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Instruction and Technical Manual for Prototype Landing Signal Officer's Display System

Charles C. Gordon

Measurement Engineering Division
Institute for Applied Technology
National Bureau of Standards
Washington, D. C. 20234

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Interim Report

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NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, Director

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INSTRUCTION AND TECHNICAL MANUAL
FOR
PROTOTYPE LANDING SIGNAL OFFICER'S DISPLAY SYSTEM

1.0 Introduction

This manual describes the prototype Landing Signal Officer's (LSO) Display System that is installed aboard the aircraft carrier USS Ranger CVA61. The prototype LSO Console was designed and engineered to fulfill requirements proposed in a study for an improved LSO work station(1). The first four sections (1.0 thru 4.5) of this manual provide the information needed to operate the equipment, while the remaining sections give a technical description of the equipment and will be useful when service or modifications are required. The technical sections are written to be used in conjunction with the electronic and mechanical drawings furnished with the equipment.

The display system consists of two major parts: a Display Console, Figure 1, located at the LSO station, and an Auxiliary Electronics Cabinet, Figure 2, located one deck directly below the LSO platform. The information displayed by the Console is obtained from the ship's radars and recovery-status sources.

The front panel of the Console contains scales and indicators that display Airspeed, Range, Rate of Descent, Ramp (or deck) Motion, Aircraft Type, Wind Direction and Speed, Deck Status, Pilot Landing Aid Television (PLAT), and Automatic Carrier Landing System (ACLS) operating status. In addition, the Console provides a Head-up Display (HUD) that shows Airspeed, Range, Ramp Motion, and aircraft Glide-Slope position. The HUD information is optically focused to appear at infinity and it can be superimposed on the sky by Console tilt and rotation. This enables the LSO to see a distant aircraft and the HUD Display in the same field of view; both are simultaneously in focus. Cross lines in the HUD are glide-slope reference lines for showing the position of its electronically generated Aircraft Symbol, but do <u>not</u> function as a "gunsight" reference to use the HUD for visual aircraft tracking.

The Auxiliary Electronic Cabinet, Figure 2, contains the interface and signal processing electronics between the ship's signal sources and the Console displays. This cabinet is located in the emergency escape room for the LSO which is directly below the LSO platform. The cabinet is secured to the inside wall of this room with its front facing the watertight door. All the input and output signal cables as well as the power cables come into the front of the cabinet. The cables between the Auxiliary Electronic Cabinet and the LSO Console go through the outside bulkhead of the room using watertight fittings. All the ship's source signals come into a Signal J-box and a Synchro Signal J-box. These boxes are mounted on the inside of the outer bulkhead of this room and are the distribution points for the signals to the Auxiliary Electronic Cabinet.

The Auxiliary Electronic Cabinet is divided into an upper and a lower section which are accessible by sliding either section forward. Figure 3 shows a top view of the upper chassis. Significant components visible in this photograph are labeled. The lower chassis is shown in Figure 4. The visible components are also labeled for identification. The Scale and Display card cage has been doubled in size and extends nearly to the front of the panel for the final installation on the Ranger. This was necessary in order to include interface cards for the SPN-44, wind, and aircraft type information. Not visible in this lower chassis are power supplies for the CRT, cards, and lamps.

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(1) Landing Signal Officer: Work Station Design, Technical Report 1707, Dec. 1970 by Gail J. Borden, Human Factors Research, Inc.

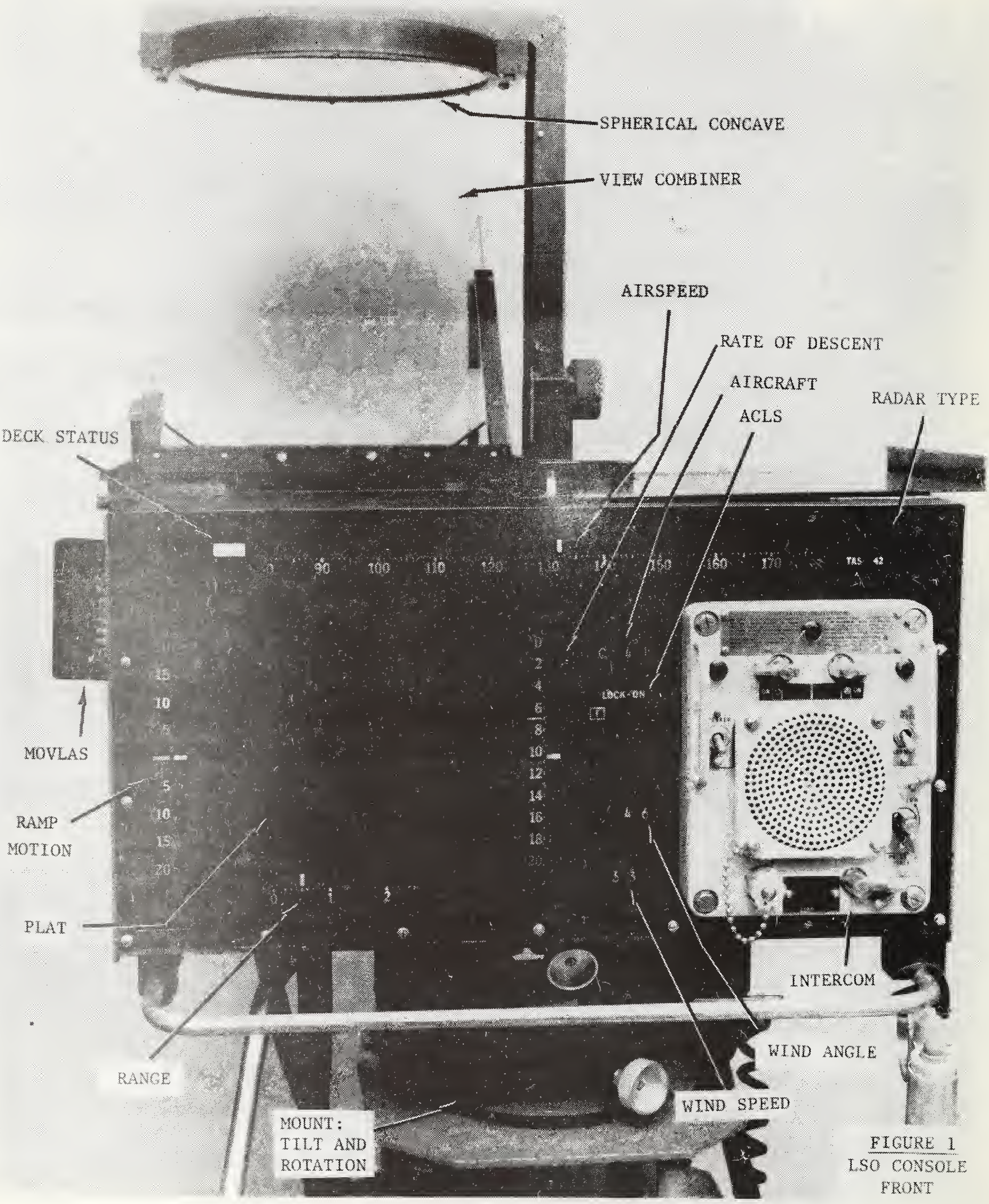


FIGURE 1
LSO CONSOLE FRONT

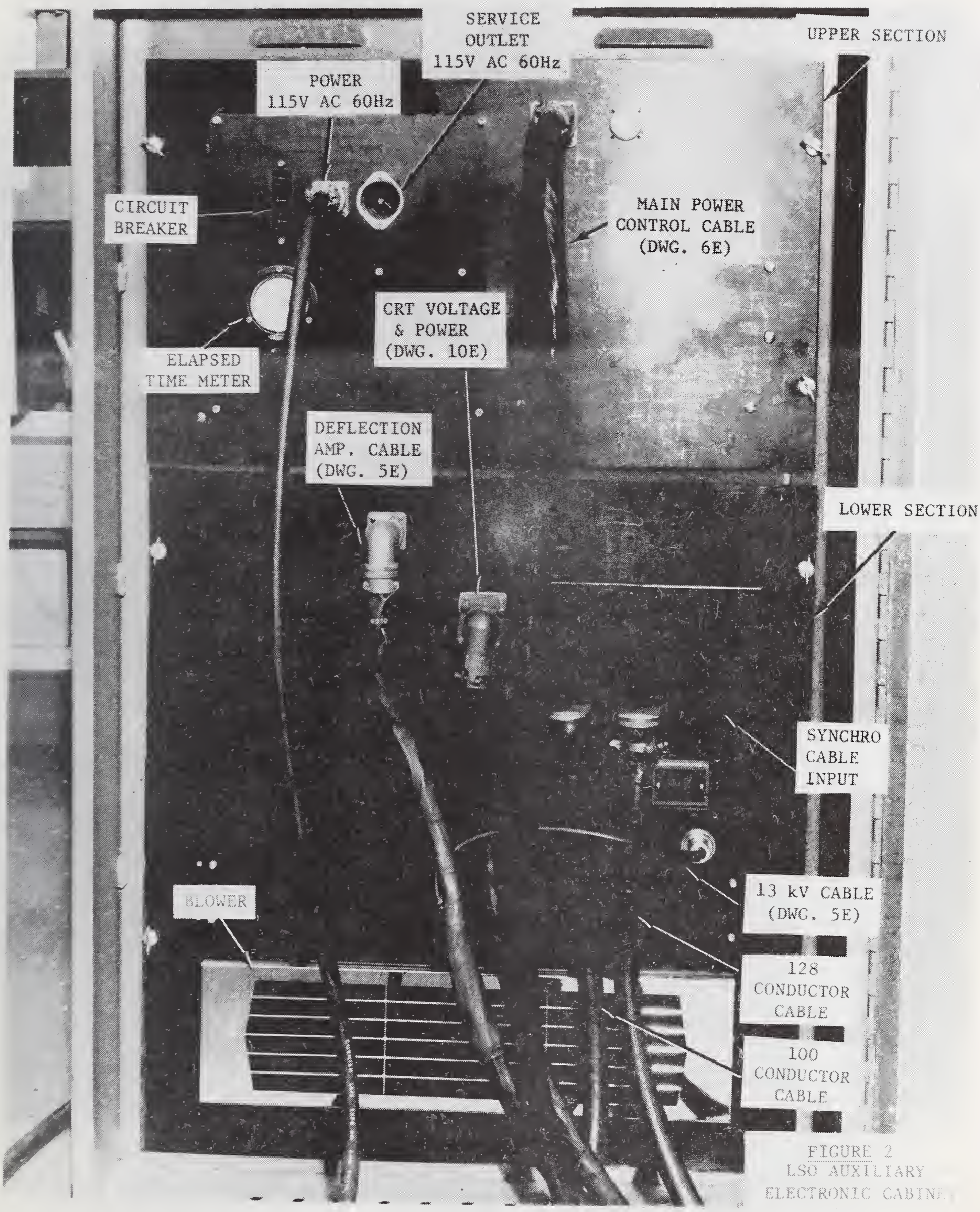


FIGURE 2
LSO AUXILIARY
ELECTRONIC CABINET

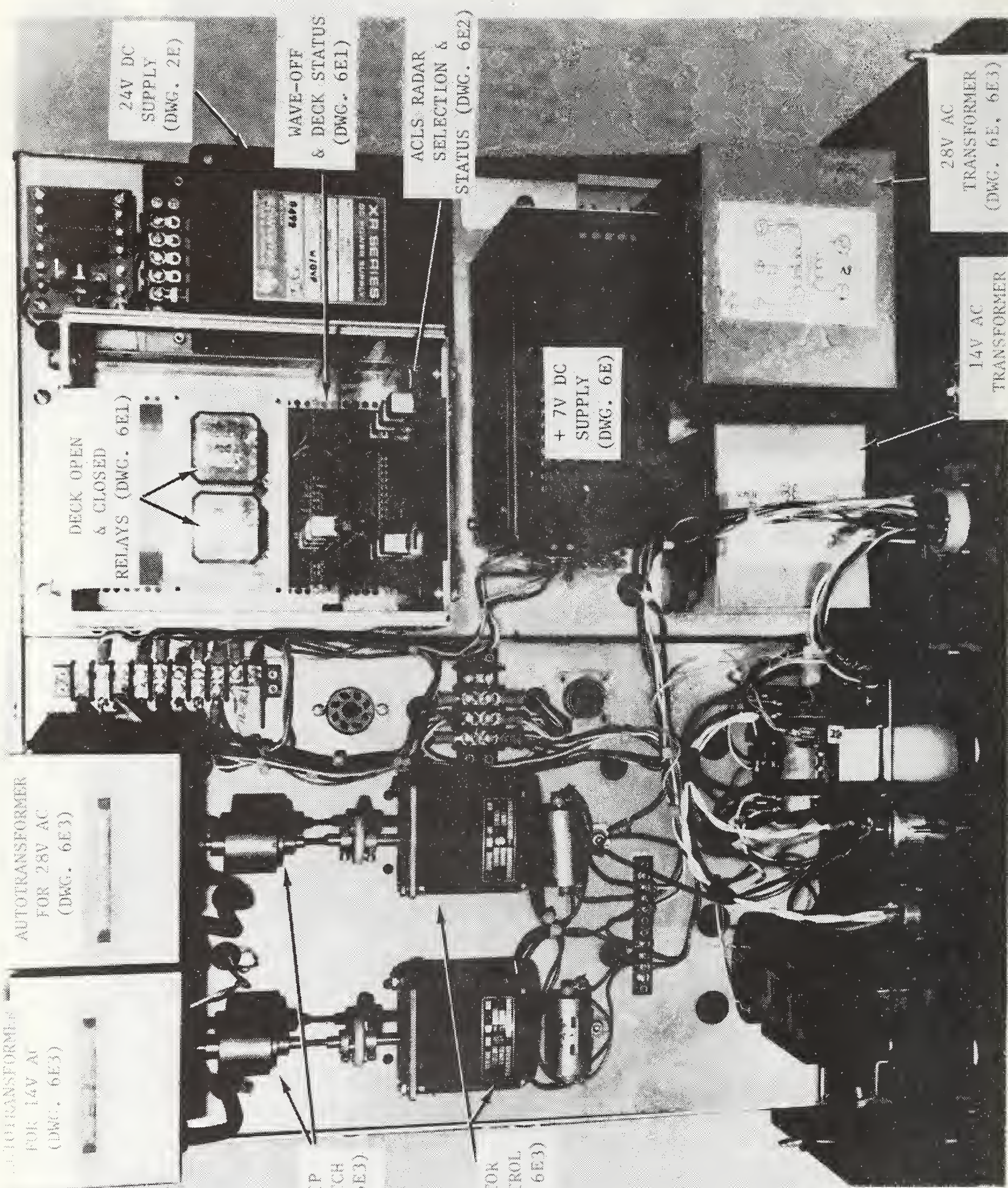
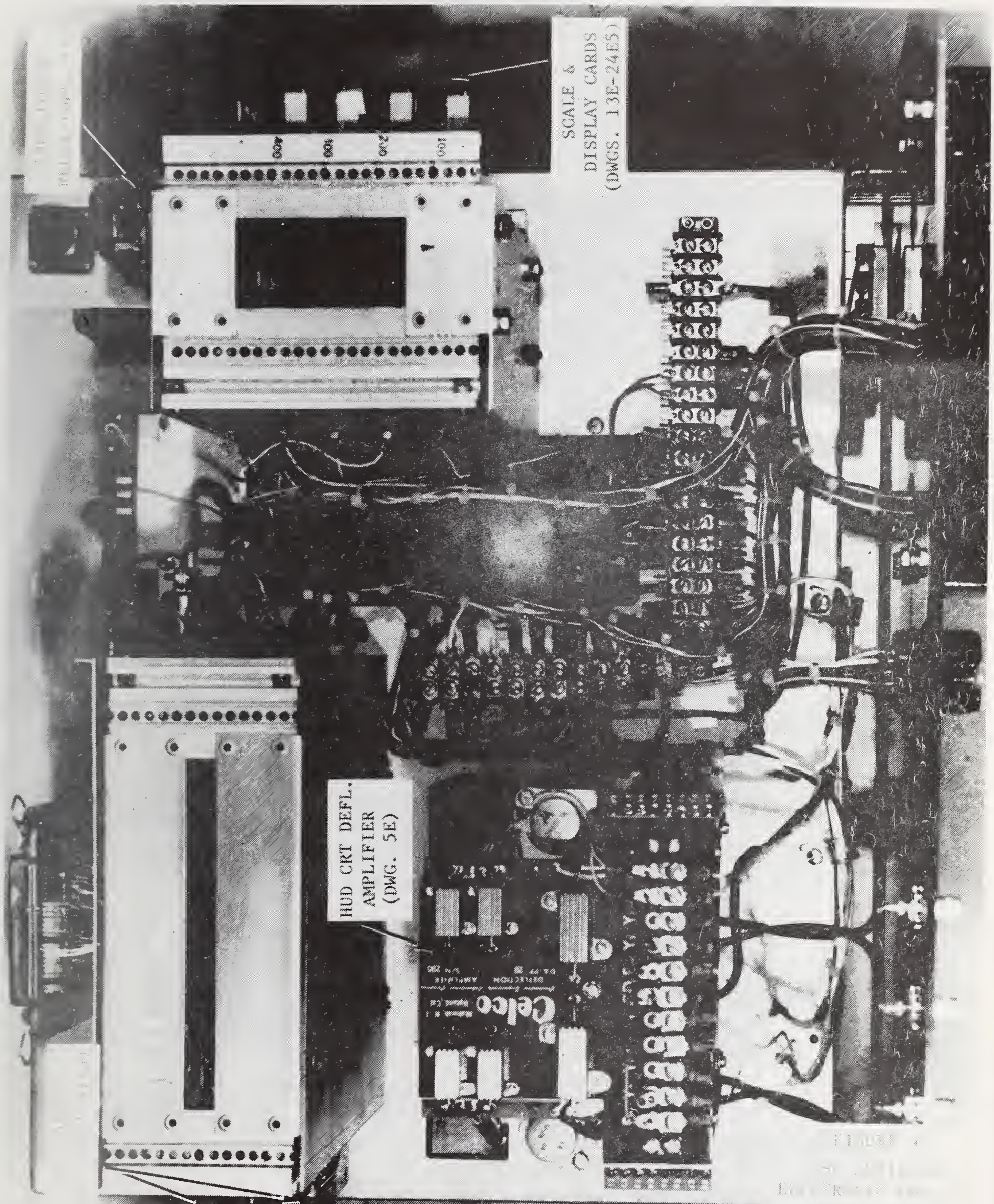


FIGURE
LSO AUXILIARY
ELECTRONIC CABINET
UPPER SECTION


SCALE &
DISPLAY CARDS
(DWGS. 13E-24E5)
HUD CRT DEFL.
AMPLIFIER
(DWG. 5E)
Celco

1.1 Specifications

1.1.1 Displays

(1) Airspeed: 80 to 180 knots, one knot resolution, approx. 38.5 cm (15.15 in) scale, incandescent moving pointer indicator, adjacent trend pointer.

(2) Range: 0 to 3 nautical miles, 0.1 nautical mile resolution, approx. 11.8 cm (4.65 in) scale, incandescent moving pointer indicator.

(3) Rate of Descent: 0 to 2000 ft/min, 50 ft/min resolution, approx. 15.6 cm (6.15 in) scale, incandescent moving pointer indicator, adjacent trend lamp.

(4) Ramp Motion: 0 to + 20 ft and -19 ft, with one foot resolution, approx. 15.6 cm (6.15 in) center zero scale, incandescent moving pointer indicator, trim lamp for ship's trim independent of Ramp Motion.

(5) Deck Open: Green lamp

(6) Deck Closed: Red lamp

(7) LSO Wave-Off: Red flashing, 90/min

(8) True Airspeed: White light, TAS, indicator

(9) Closing Airspeed: White light, CLSG, indicator

(10) SPN-42: White light, 42, indicator

(11) SPN-12/44: White light, 12/44, indicator

(12) Aircraft Type Designator: Alpha-numeric incandescent characters for A3, A4, A5, A6, A7, C1, C2, E1, F4 and F8 aircraft.

(13) Automatic Carrier Landing System (ACLS): Incandescent characters for Lock-On, Modes I, II, or III.

(14) ACLS Wave-Off: Blue flashing, 180/min

(15) Wind Angle: Alpha character for port (P) or starboard (S) and numeric characters of 0° through 50° for angle, incandescent.

(16) Wind Speed: Incandescent characters for 0 to 99 knots.

(17) PLAT: Pilot landing aid television monitor

(18) MOVLAS: Incandescent repeater of the ship's Manually Operated Visual Landing Aid System.

1.1.2 Head-Up Displays (HUD)

(1) Mirror: 10-inch diameter, spherical concave of 18-inch focal length.

(2) Combiner: 30% reflectance, 70% transmittance, 1/4 inch safety glass, 10-1/2 inches by 13-1/2 inches.

(3) CRT: High intensity HUD type, 3 inch diameter, 70° deflectance, 14kV anode, 6.3V filament.

(4) Airspeed display: 80 to 180 knots of true airspeed.

(5) Ramp Motion: ± 20 ft of ship's ramp motion or ship's trim separately.

(6) Glide-Slope Path: Aircraft symbol showing azimuth and altitude relative to the touch-down-point with 30 ft or 10 ft scale factor selection. Azimuth of 240 ft left and right and altitude of +240 ft up and -150 ft down are indicated with the 30 ft scale factor. Azimuth of 80 ft left and right and altitude of +80 ft and -50 ft are indicated with the 10 ft scale factor.

(7) Range Circle: Appears when range of aircraft is one mile or less from the carrier and disappears as a function of its distance from the carrier as the aircraft approaches the deck 3/4 circle equals 3/4 mile, 1/2 mile, 1/4 circle equals 1/4 mile, etc.

1.1.3 Intercom Unit: Two station 21MC (LS-458/SIC) unit for communication to Primary Flight (Pri Fly) or Carrier Traffic Control Center (CATCC).

1.1.4 Power Required: 115V, 60 Hz, single phase, 15 ampere.

2.0 Console Displays and Controls

2.1 Console Mount and Controls

The console is located at the LSO platform and is mounted on a hydraulic platform, Figure 5. The hydraulic platform is built around a hydraulic anchor damper (Mark VII, Mod. II) from the ship's arresting gear. The anchor damper is mounted for vertical travel. When lowered, the LSO console is below the LSO platform and is stored in an aluminum box with a weatherproof cover, Figure 6. With the platform raised to its highest position the center of the HUD combiner glass is 73 inches above the deck. The platform can be stopped and locked in any lower position for a shorter LSO by the use of the up and down hydraulic valve selector switch and the motor control switch. A TV-type panning head is mounted between the hydraulic platform and the console, thereby allowing the console to be rotated horizontally and tilted. Viewing problems caused by the sun, glare, or other lighting conditions can be minimized by utilizing the panning head.

2.2 Displays and Controls

No controls for the console displays are located on the front panel. The controls for the Pilot Landing Aid Television monitor (PLAT) are located on the left side of the Console, Figure 7, and all other console display controls are on the right side of the Console, Figure 8.

2.2.1 Intercom and PLAT

A standard, two-station, intercommunication station (LS-458/SIC) is mounted on the right side of the Console front panel. It communicates with Primary Flight (Pri. Fly) and the Carrier Traffic Control Center (CATCC). All of its controls are on the front and it is powered from the ship's intercom system.

At the center of the left side of the front panel is the Pilot Landing Air Television monitor (PLAT), which connects to the ship's common centerline television camera that views the aircraft approaching for a recovery. The on-off switch, contrast, brightness, horizontal hold and vertical hold controls for the PLAT are on the left side panel, Figure 7.

2.2.2 Pointer Displays

The PLAT is framed by four, pointer-type displays; Airspeed, Range, Rate of Descent, and Ramp (or Deck) Motion. Each display consists of a row of incandescent lamps adjacent to a calibrated scale that is separately back-lighted. Each row of lamps serves the function of a scale pointer, the pointer position being indicated by turning on the appropriate lamp. The lamps are mounted in individual compartments, and in order to provide redundancy two lamps are mounted in each compartment. Each of the four pointers has its own intensity control and its own on-off toggle switch, located on the right side panel, Figure 8. Individual control of the backlighting for the four

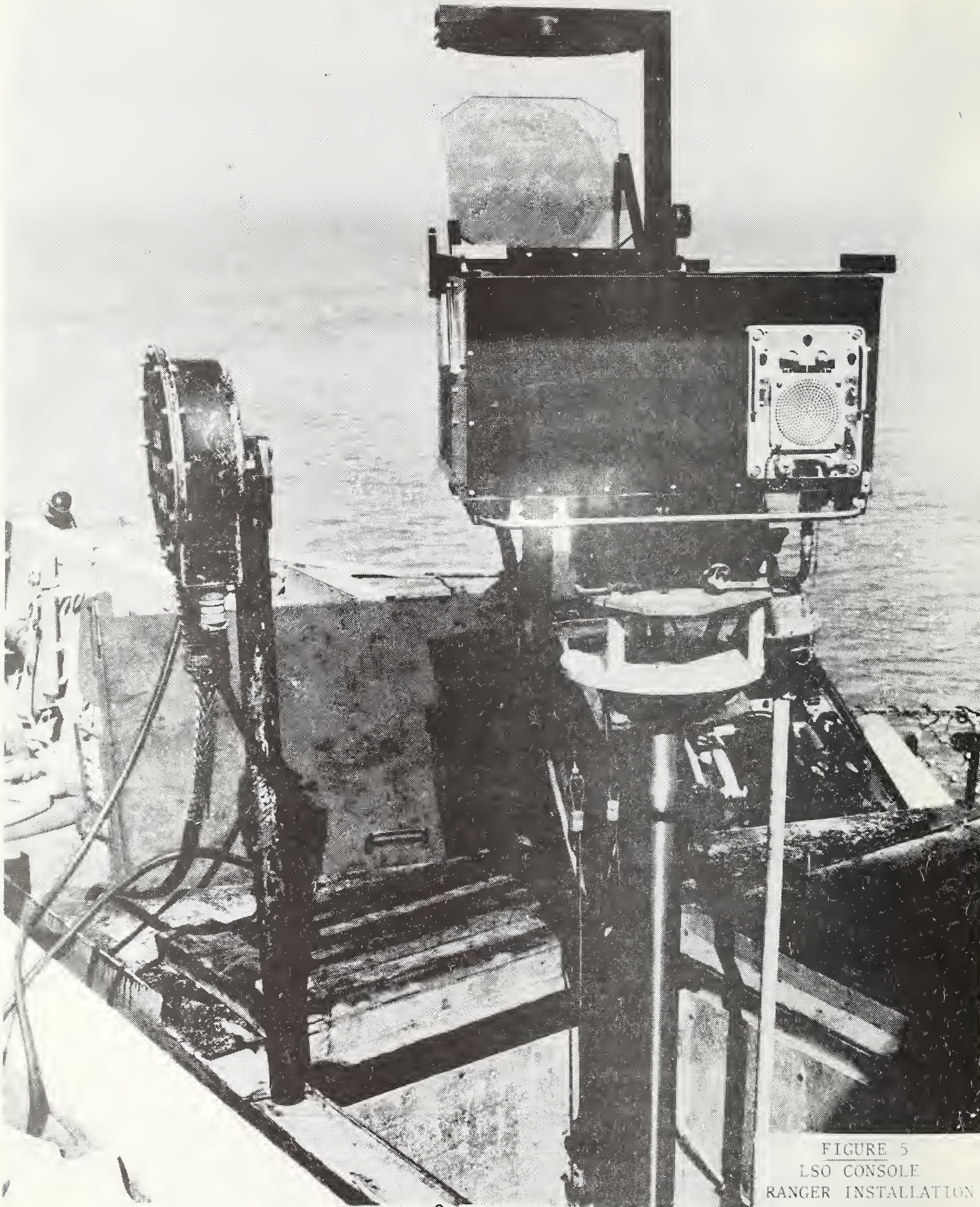
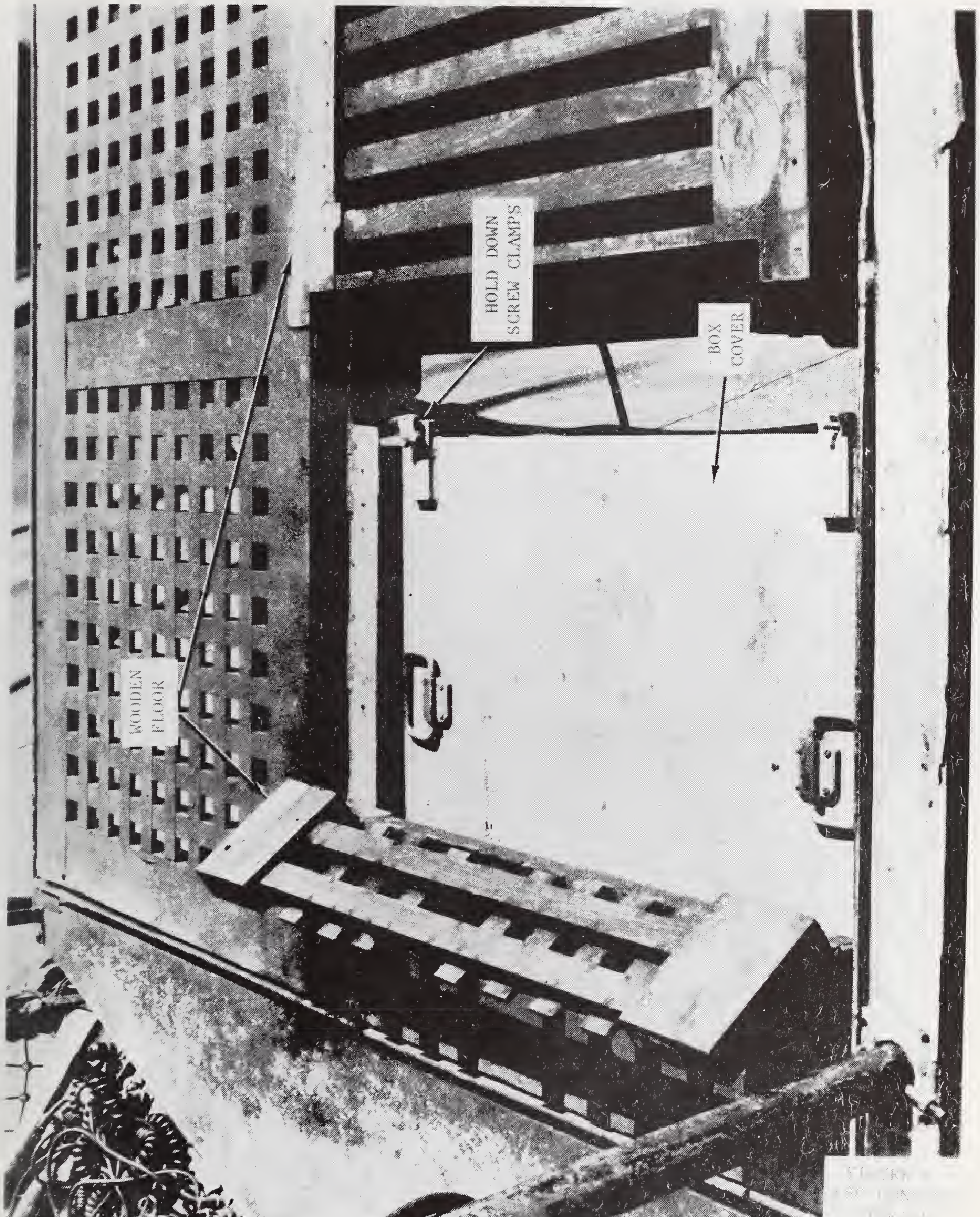


FIGURE 5
LSO CONSOLE
RANGER INSTALLATION


HOLD DOWN SCREW CLAMPS
BOX COVER
WOODEN FLOOR

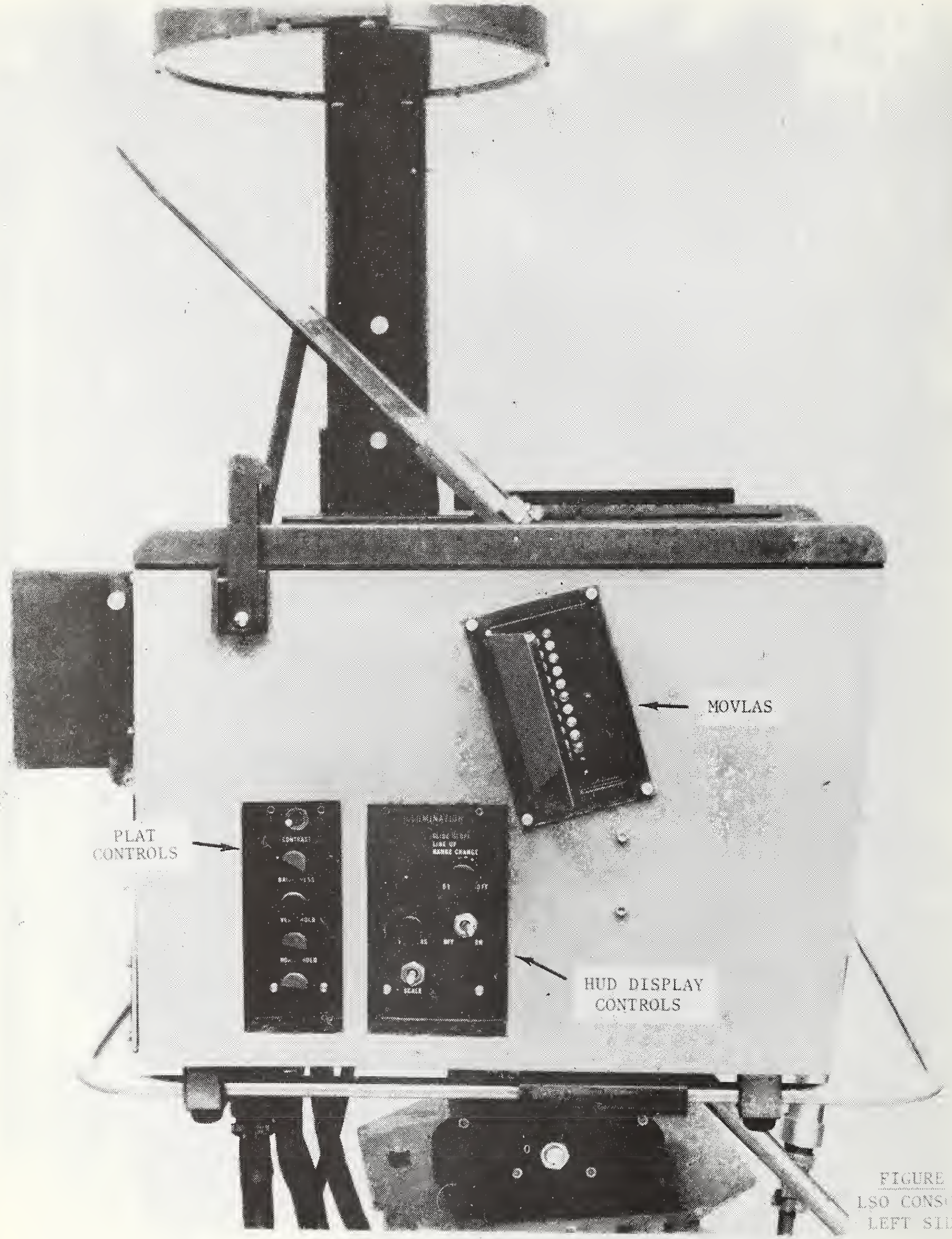


FIGURE [illegible]
LSO CONSOLE
LEFT SIDE

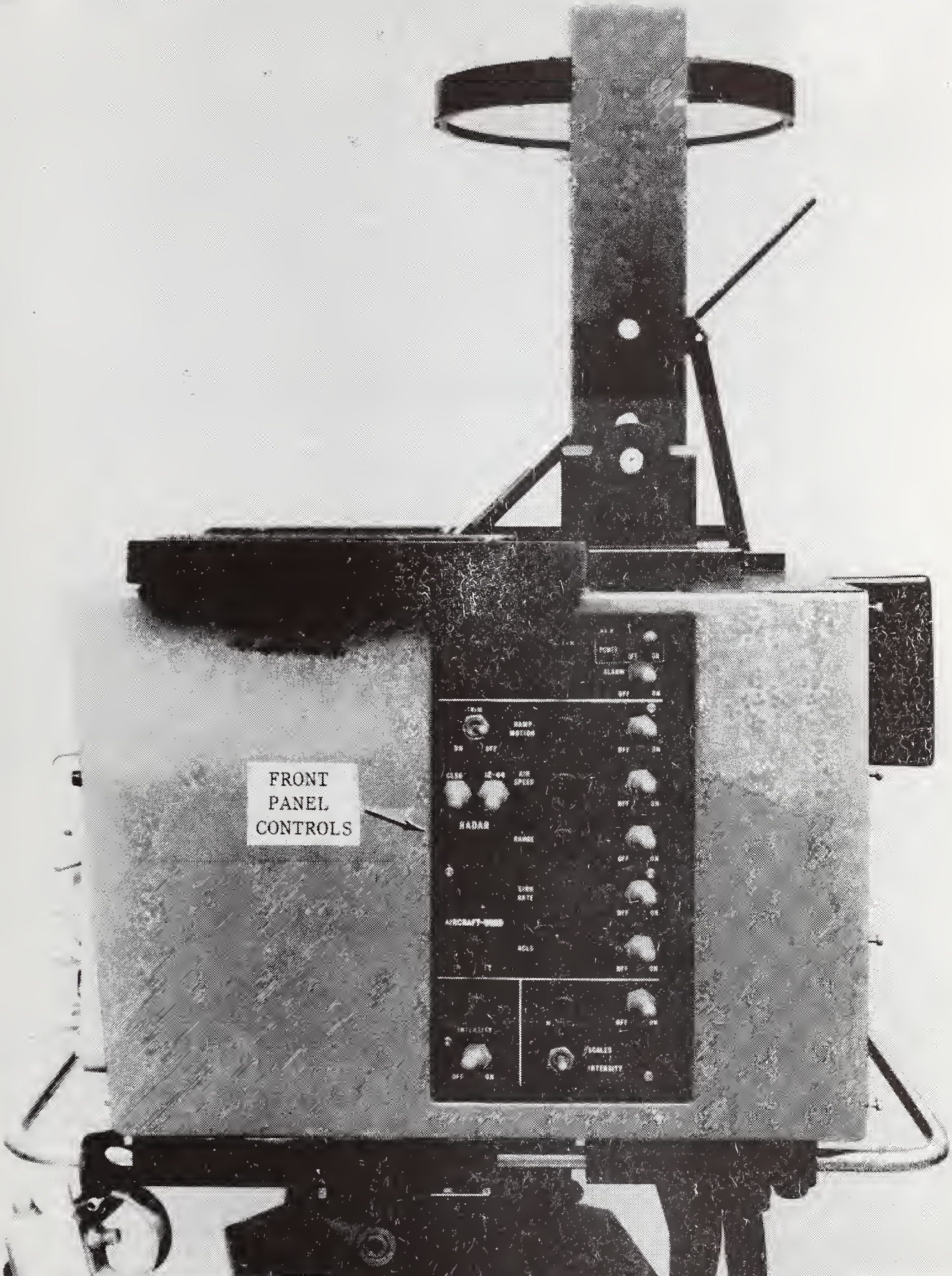


FIGURE 8
LSO CONSOLE
RIGHT SIDE

scales is not provided. Instead, a single toggle switch provides ON-OFF control; and a momentary action double-throw, center OFF, toggle switch controls intensity. Holding the switch UP will increase intensity, and holding it DOWN will reduce intensity.

2.2.2a Airspeed

The Airspeed scale, located above the PLAT, covers the range of 80 to 180 knots. Its pointer will stay at 80 knots when the correct value is less than or equal to 80, and will read 180 knots whenever the correct value is equal to or greater than 180. A trend light is adjacent to the main pointer. When the airspeed is increasing, the trend lamp is one knot less and with decreasing airspeed, the trend lamp is one knot greater. Either true airspeed (TAS) or closing airspeed (CLSG) may be chosen for presentation. The selection is made by the TAS/CLSG toggle switch located near the middle of the right side control panel. The choice thus made is shown by the letters TAS or CLSG appearing at the right-hand end of the Airspeed scale. In addition, either the ship's SPN-42 radar or its SPN-12/44 radar can be selected as the source of the airspeed signal. The selection is made by the SPN-42 or SPN-12/44 toggle switch, and the choice thus made is indicated at the right-hand end of the Airspeed scale by the presence of the number, 42 or the number, 44.

2.2.2b Rate of Descent

The Rate of Descent scale is the vertical scale to the right of the PLAT. It indicates the rate of descent in hundreds of feet per minute for an approaching aircraft. The scale covers a range of zero to a maximum of 1912 feet per minute with a resolution of 50 feet per minute. If the rate of descent is greater than 1912 feet per minute, it will continue to read this value. A trend lamp adjacent to the main pointer and of lesser intensity is used to indicate the direction of change for rate of descent. If the trend lamp is a higher number, the rate of descent is decreasing; and if it is a lower number, the rate is increasing.

2.2.2c Range

The console Range Scale is below the PLAT display. It operates when the aircraft is 3 nautical miles or less from the touchdown point. Its pointer will remain at 3 miles when the range is 3 miles or greater. The scale has a resolution of 0.1 nautical mile.

2.2.2d Ramp Motion

The Ramp Motion Scale is the vertical scale to the left of the Plat display. The input information source is the ship's Harmonization Computer (SFHC) instead of the SPN-42 radar. It indicates ramp motion plus ship's trim in the normal operating mode. A momentary toggle switch on the right side control panel is used to select ship's trim as a separate display on the Ramp Scale. A Trim lamp below the scale comes on when ship's trim is being selected for display. The scale is a zero center display with a range of +20 feet of high ramp to -19 feet of low ramp. The area between +10 feet and +20 feet is covered by a red filter to produce a red pointer indication. This is the danger area and warns the LSO of a possible ramp strike. The ramp pointer remains at full scale when the ramp motion exceeds the +20 or -19 feet extremes.

2.2.3 Deck Open and Closed and LSO Wave-Off

Three deck status indicators are located on the left of the Airspeed Scale. A green light indicates the deck is open and ready to

land aircraft. An adjacent red light indicates a closed deck and any approaching aircraft must not land. With a closed deck, any aircraft is given a wave-off. The LSO initiates a Fresnel Optical Landing System Wave-Off (FLOLS wave-off) with a "pickle-switch". The wave-off is indicated by the red flashing lamps below the open and closed deck lamps. The rate is approximately 90 flashes per minute.

2.2.4 Aircraft Type

The aircraft type that is being recovered on each landing is indicated by one alpha and one numeric character. These characters are displayed between the Rate of Descent scale and the Intercom station just above the ACLS status indicators. This display is set up by signals from Pri. Fly and is used for verification between the recovery set up and the aircraft in the glide-slope to be recovered. Seven-segment, incandescent lamp indicators are used for the alpha-numeric aircraft type characters.

2.2.5 ACLS Status

The operating status of the Automatic Carrier Landing System (ACLS) is indicated just below the aircraft type by backlighted indicators. The ACLS system indicates a Lock-On and three modes of operation. Mode I is a full ACLS landing. Mode II is an instrument landing approach and Mode III is a "talk down" landing. The mode indicators are below the Lock-On light. The ACLS system generates a wave-off when data obtained from the computer and radar system or aircraft response to the landing instructions are questionable. The ACLS wave-off signal is displayed as a blue flashing light below the Model lamps. The flash rate of this wave-off is approximately 180 per minute.

2.2.6 Wind Angle and Speed

The wind angle, either port (P) or starboard (S), and the magnitude of the angle in degrees is indicated by three alpha-numeric characters below the ACLS Status displays. The angle is relative to the centerline of the angled landing deck which is 10 degrees to port of the ship's centerline. Therefore, wind down the centerline of the ship would be indicated on the Console as an S 10° wind. Seven-segment, incandescent indicators are also used for these alpha-numeric characters. Approximately 50° can be displayed by the wind angle indicators in either the port or starboard direction. Normal landing operations are conducted with the wind within 10° of the centerline touch-down-point.

The two numeric characters below the wind angle indicators display the wind speed. These are capable of 0 to 99 knots indication. The characters are the same type as in the wind angle display. Normal operations are 30 knots of wind speed at the proper angle down the recovery deck.

2.2.7 MOVLAS

The MOVLAS is a repeater which operates when the ship's Manually Operated Visual Landing Aid System (MOVLAS) is used. The MOVLAS repeater is located on the left side of the console, Figures 1 and Figure 2. The repeater duplicates at the LSO Console the MOVLAS display of datum bar and "meatball" lights that the pilot sees. The MOVLAS repeater has a separate on-off switch and intensity control which are located on the right side panel of the console, Figure 8.

2.3 Head-Up Display

Figure 6.2.1 shows the information displayed by the Head-Up Display (HUD). Some of this can also be seen in the View Combiner in, Figure 1. The eyes of the observer should be in front of, and at the same height as the display. Positioning the eyes too far to the side, or too high or low, will cause part or all of the display to disappear from sight. A relative narrow

angle of view is a characteristic inherent in all HUD's. The HUD display should be adjusted to approximately the same viewing angle as the glide-slope path of the approaching aircraft. This permits a horizontally shift of the eyes to monitor the HUD information without lowering the head. Left and right views of the HUD in position are shown in Figures 7 and 8 respectively. Figure 9 shows the Console back with the lamp housing open. Figure 10 is a view of the top of the Console with the combiner glass removed.

2.3.1 Airspeed

The Airspeed scale covers the range of 80 to 180 knots and always indicates true airspeed (TAS). Its pointer will disappear off scale if the speed is more than a few knots outside of this range.

2.3.2 Ramp Motion (or Deck Motion)

Ramp Motion is the vertical scale at the extreme left. This scale displays Ramp Motion which includes the ship's trim. The pointer will move off-scale if the scale limits are exceeded. Otherwise it is identical to the Ramp Motion display that is on the Console front panel. Ship's trim without ramp motion can be obtained by using the trim only switch to display trim on the front panel ramp scale.

2.3.3 Aircraft Range

Aircraft Range is displayed as a large, disappearing circle. When the aircraft is more than one nautical mile away, the circle does not appear. When the aircraft approaches to 0.99 miles, a nearly complete circle suddenly appears on the display. At 0.5 miles, half a circle remains; at 0.25 miles a quarter of the circle remains visible; and so on until at about 0.01 miles the circle disappears completely. The circle, or portions thereof has a constant diameter at all times.

2.3.4 Glide-Slope Line Up

Glide-Slope Line Up information is presented by the location with respect to reference cross lines, of an electronically generated aircraft symbol. A choice of two scale factors is available, 30 feet per division (ft/div) and 10 feet per division. To indicate to the observer that the 30 ft/div is in use, the aircraft is represented as a small circle. Wings and a tail are added when the 10 ft/div scale factor is in use. The selection is made with a three position rotary switch on the HUD illumination panel. The third position is an automatic (Auto) mode and is the preferred position for normal operation. This mode produces a scale factor of 30 ft/div for the aircraft symbol when the aircraft is more than one nautical mile away, and a symbol scale factor of 10 ft/div and the range circle (Sec 2.3.3) when the aircraft is less than one mile away. For the 30 ft/div scale factor, the displacement of the aircraft symbol is electronically limited so that the symbol will remain in view no matter how far the aircraft is from the desired glide slope. With the 10 ft/div scale factor, the symbol can be driven completely out of view.

3.0 Console Operation

The following procedures for operation of the LSO Console apply to the unit as installed on the LSO platform of the USS Ranger, CVA61.

3.1 Fold back the wooden floor over the console storage box, Figure 6.

3.2 Remove the storage box cover by releasing the four hold down screw clamps, Figure 6.

3.3 Store the box cover in the vertical rack provided at deck level just forward of the platform.

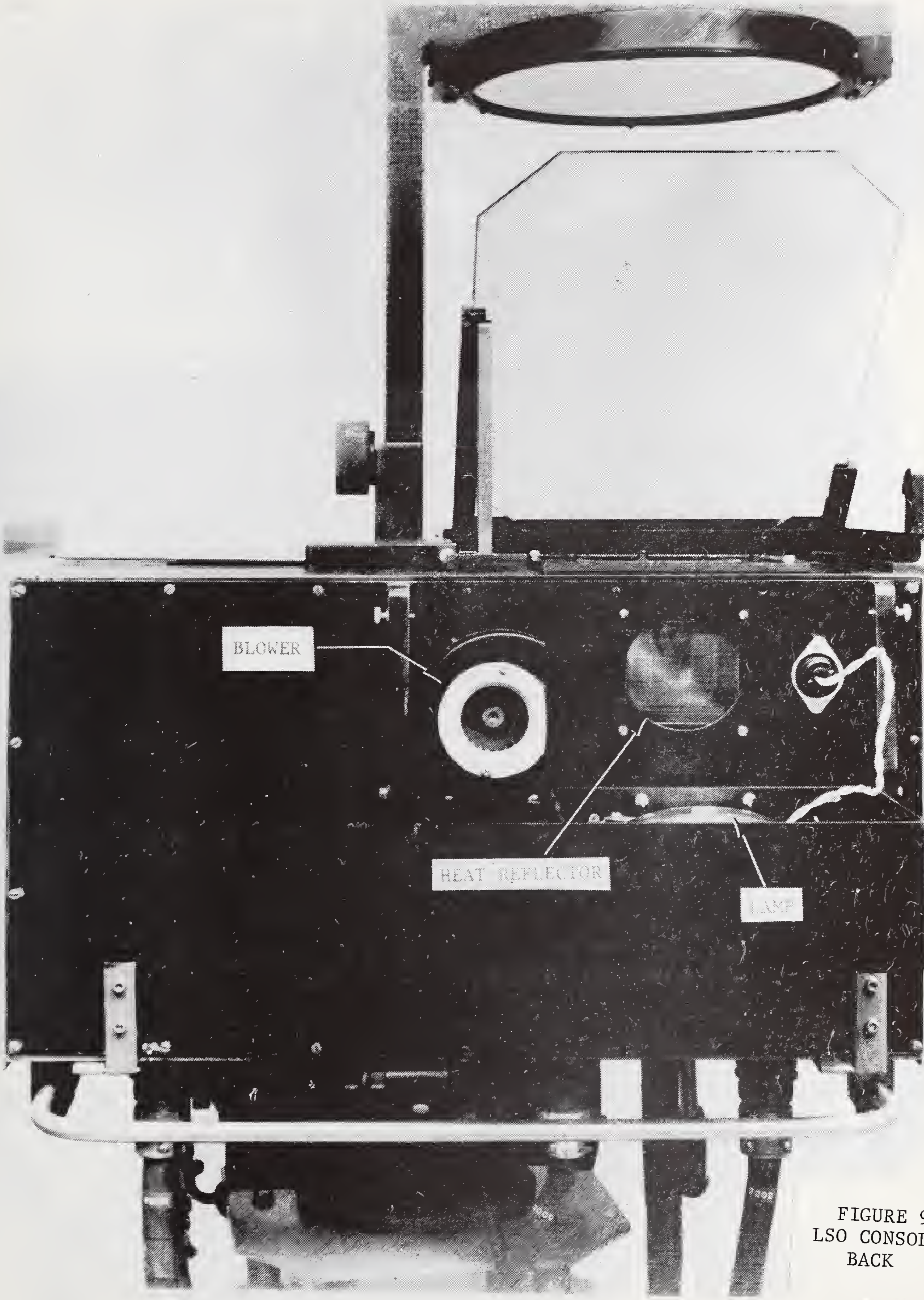
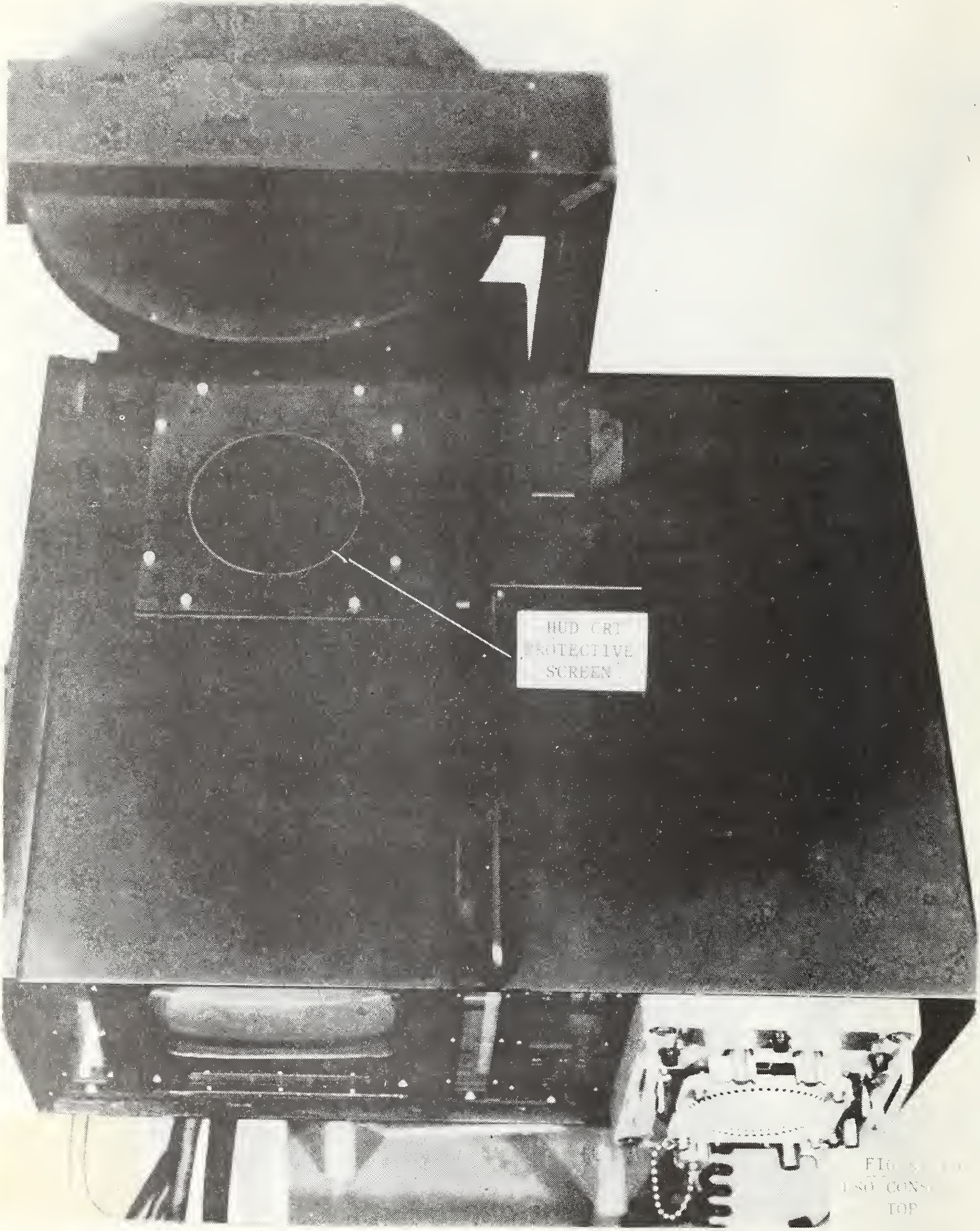


FIGURE 9
LSO CONSOLE
BACK



FIG

TOP

3.4 Place the hydraulic valve selector in the up position. This is with the pointer up and handle down.

3.5 Make sure the LSO Console will not strike any of the box sides when being raised.

3.6 Press and hold the motor switch to raise the unit to the desired height for the operating LSO. Release the motor switch. If it is necessary to lower the console, change the hydraulic valve selector switch to pointer down and operate the motor switch. The hydraulic valve selector switch must either be placed in the neutral (horizontal) position or returned to the up position to prevent the console from creeping down.

3.7 Release the spherical concave mirror latch and raise the mirror into place, firmly securing it with the large diameter knurled knob.

3.8 Flip the combiner protector cover to the right side. Magnetic strips will hold it in place.

3.9 Hold the top edge of the combiner glass with the fingers of the left hand, compress the two center knobs together at the center of the frame base, lift the top edge with the left hand while sliding the bottom edge forward until it stops with the glass at a 45° angle, release the compressed knobs in the right hand making sure the pins snap into the track holes to secure the glass in place. See Figure 5 for the LSO Console in the operating position.

3.10 Uncover the MOVLAS on the left side by opening its door to a 45° angle, Figure 7.

3.11 On the left side, Figure 7, turn the pointers control knob completely counterclockwise and the toggle switch to OFF on the HUD Illumination Panel. This prevents the HUD CRT from being too bright when power is applied.

3.12 The console is now ready for application of Main Power.

In the following steps use Figure 8 as a reference. This is a photograph of the right side control panel.

3.13 Turn the Main Power switch on.

3.14 Adjust the Deck Open or Closed, radar type SPN42 or SPN12/44 and Closing (CLSG) or True (TAS) airspeed lamps to the desired intensity with the Lamps Control in the Deck Status Section of this panel. Note: The alarm is not used on the Ranger so these controls do not function.

3.15 Turn on the Ramp Motion, Airspeed, Range, Sink Rate (Rate of Descent), ACLS and MOVLAS switches. These are adjacent and to the right of each potentiometer control for each function. Turn on the panel intensity control switch in the lower left corner of this panel if illumination of the right and left control panels is required.

3.16 If the console is being used in daylight turn off the panel intensity control switch since each panel is etched with white letters for daylight use. For night or low light level use, adjust the panel intensity level with the potentiometer control which controls both right and left panels.

3.17 Adjust each pointer of the four display scales to the desired intensity for the existing ambient light.

3.18 Adjust all scale intensities with the single Scale Intensity control. This is a center off switch which is momentary in both directions from center. Holding this switch up increases the scale intensity, holding it down lowers the intensity.

3.19 The ACLS control adjusts the Lock-On, Mode I, II or III intensities of the ACLS status display.

3.20 The Aircraft-Wind Control adjusts the intensity of the Aircraft Type and Wind displays.

3.21 Use the two toggle switches to select the proper type radar input; either, SPN42 or SPN12/44 and TAS or CLSG for the airspeed to be displayed. The intensity for these displays was adjusted in 3.14 of this section.

3.22 Adjust the MOVLAS intensity with its potentiometer control.

Use Figure 3 as the reference for the following adjustments. This is a photograph of the left side console control panel. Note: The HUD illumination Panel has the Glide Slope Line Up Range Change switch replaced with a 3 position switch for the Ranger console. The positions are (1) Auto, (2) 30 feet, (3) 10 feet, see Dwg. 27E.

3.23 Turn the HUD display on with its ON-OFF switch.

3.24 Use the Scale toggle switch to adjust the HUD scale intensity. This is a momentary switch. Holding it up, increases and holding it down, decreases the HUD scale intensity.

3.25 Adjust the pointer intensity on the CRT HUD display with the Pointers control potentiometer adjacent to the ON-OFF switch.

3.26 Set the Glide-Slope for aircraft symbol display as desired with the Auto, 30 feet or 10 feet switch as follows:

(a) Auto: This is in general the most desirable position for normal operations. When the aircraft has greater than a one mile range, the aircraft symbol is a round circle and the crossline scale marks represent 30 feet each. When the aircraft comes within one mile, the range circle of one nautical mile appears (see Figure 5.2), and the aircraft symbol adds a tail and wings and each scale mark represents 10 feet from the touch-down-point represented by the center of the cross hairs. As the aircraft approaches the range circle disappears in a counterclockwise direction. The portion of the circle remaining displays the range; 1/4 circle means 1/4 nautical mile range, etc. The circle disappears at touchdown of the aircraft.

(b) 30 feet: In this position the aircraft symbol will always be a round circle and never have wings and tail. Each cross mark will represent 30 feet off the touch-down-point throughout the recovery. The range circle will appear at one mile and operate as in part (a).

(c) 10 feet: In this position the aircraft symbol will always have wings and tail and each scale mark represents 10 feet from the touch-down point. The range circle will appear at 1 mile and operate as in part (a).

3.27 Turn on the Plat at the panel switch.

3.28 Adjust the Plat with the Contrast, Brightness, Vertical and Horizontal Hold controls provided below the ON-OFF switch for the best visibility for the existing operating conditions.

3.29 The tilt and angular rotation of the console is adjusted for the best operating conditions with the TV type panning head controls.

4.0 Console Storage

The folloiwng procedure should be used for storing the console after landing operations are complete.

4.1 Blank the CRT pointers with the Pointer Control, Figure 7.

4.2 Turn off the HUD Illumination with the ON-OFF toggle switch, Figure 7.

4.3 Turn off Main Power only after doing No. 1 and No. 2. This protects the HUD CRT. It is not necessary to turn off the other displays on the console. This procedure leaves the intensity controls set at the level of the last operation and could require only minor adjustments when landing operations are renewed.

4.4 If the external optics and console have become very dirty or wet due to landing operations, clean and dry them. To remove dirt, JP-5 fuel, etc., use alcohol, mild detergent in water, and fresh water rinse in that order to clean the combiner, the spherical concave mirror and the HUD protective glass cover. Do not rub hard. Dry with a soft, clean cotton cloth or cotton. Clean the circular-polarized panel using the same techniques. Wipe the balance of the Console free of dirt or moisture with a soft cloth.

4.5 Go to item No. 10 in the Console Operation section and reverse steps No. 10 through No. 1 of this procedure to store the LSO Console below the platform.

Technical Details of the Equipment

The material contained in this section describes the operation of the circuits used in the console to generate the display. This material is to be used in conjunction with a set of circuit and block diagrams supplied with the equipment. A list of these drawings is included in the Appendix.

This information applies only to the console as installed aboard the USS Ranger for testing and evaluation of this prototype. Analysis of these tests is expected to result in a final design from this preliminary model. The material is divided into sections 5.0-12.0.

5.0 Main Power Control and A.C. Wiring - Reference Drawing 6E3, and Block Diagram 6E3B.

5.1 Power Panel

The LSO Console and the Auxiliary Electronic Cabinet require 115V AC 60 Hz single phase power. A maximum of 15 amperes is required. The input power line comes into the Auxiliary Electronic Cabinet on the upper section panel, (Figure 2). This panel also contains a 15 ampere circuit breaker, an elapsed time meter and a 115V AC outlet. The 115V AC outlet is to power an oscilloscope or soldering iron for equipment service.

As long as the main power switch on the console is off, neither the console nor the Auxiliary Electronic Cabinet functions when 115V AC is applied to the input panel. The only active element is a 175-watt heater located in the LSO console. This heater keeps the unit dry during storage periods. Two 90° - 100° thermo switches in series prevent overheating. The heater is turned off during landing operations when using the console.

5.2 Main Power Turn On

In order to turn main power on, the 15 ampere circuit breaker must be closed on the Auxiliary Electronic Cabinet panel and then the main power switch must be closed on the LSO console. The following occurs with this operation: (1) the 115V AC circuits in the Auxiliary Electronic Cabinet and the LSO console are activated when the relay K1 closes, (2) the elapsed time meter starts, and (3) the console heater is turned off. The elapsed time meter indicates the hours the equipment is used.

A nineteen conductor cable (19A-19V) shown in drawing 6E3 connected from the upper panel of the Auxiliary Electronic Cabinet to the LSO console (Figure 2) is the main power control cable between the two units. The additional functions of this cable, other than 115V AC control between the two units, are covered in other sections.

The cables connected to the front of the lower panel (Figure 2) will be discussed later as they relate to the equipment operation.

6.0 Head-Up Display: Reference Dwg. 1M and 8M

6.1 Head-Up Display Optics:

The two drawings 1M and 2M illustrate the optics and ray diagrams of the system used in the LSO console. The basic requirements were to project, as if at infinity, a display of the most important aircraft status information during the landing of aircraft. This display is then superimposed on the sky by using the TV panning head to set the tilt and azimuth of the console. The LSO operator can monitor this information without lowering his head (Head-Up) from the approach path or refocusing his eyes to the lower console. A 10-inch diameter, 18-inch focal length, spherical concave mirror is used to project the display as if at infinity. The display consists of true airspeed, ramp motion, range, and aircraft glide-slope path relative to the touch-down-point. By placing the information source at the focal point of the spherical concave mirror, a virtual image is produced at infinity. A nominal 30% reflectance and 70% transmittance combiner is inserted at 45° between the source and the 10-inch mirror. When the viewer looks through the reflecting side at 90° to the source-to-mirror path, a display of source information appears as if at infinity. For simplicity and cost reduction, the display scale information is etched on an illuminated reticle and the dynamic analog information for each scale is presented on a high intensity cathode ray tube (CRT). The two sources (Scale Display and Pointer Display) are combined on a polyethyleneterephthalate film pellicle of 50% transmittance and 50% reflectance to make the composite HUD information source. Each source is located so that the optical path equals the focal length of the 10-inch mirror. The reticle scale illumination is obtained by passing the light from a 250-watt,28-volt AC lamp through a heat deflector, a heat absorber, a diffuser and a green filter. This produces a green scale display of approximately 520 nanometers. The pointer display is green; the CRT phosphor is green. The two light sources in the green region are not of the same wavelength so that the pointers and scale lines are not confused. The intensity of the CRT pointer is controlled by the potentiometer, G1. This circuitry is fully described in Section 6.4. A two-direction momentary switch with a center off position is used to control the reticle scale illumination. This switch controls a motor driven autotransformer to vary the output of the 28V AC transformer for the HUD scale lamp. This circuitry is shown in Drawings 6E and 6E3.

6.2 Head-Up Display Generator - Introduction

The Head-Up Display Generator produces the dynamic portion of the Head-Up Display (HUD). The circuitry of the display generator is contained on two plug-in printed circuit cards located in the HUD chassis that is itself inside the Auxiliary Cabinet. One card is labeled CIRCUIT BOARD #1/99, Waveform Generators; and the other is labeled CIRCUIT BOARD #100/199, Display Synthesizer. Circuits that interface these two cards to the CRT are not considered part of the Head-Up Display Generator and are not described in Section 6.2. The interface circuits are a deflection amplifier, described in Section 6.3, a blanking circuit, described in Section 6.4, and a protection circuit described in Section 6.4.

6.2.1 CRT Beam Path

Figure 6.2.1 shows the visual display that is drawn by the CRT, and also indicates the time during which the various parts of the display are drawn. This figure is helpful in relating the visual display to the circuits and waveforms that drive the CRT beam. In order to relate this drawing to the circuits that generate the display, an introduction to the timing and signals that drive the CRT must be provided.

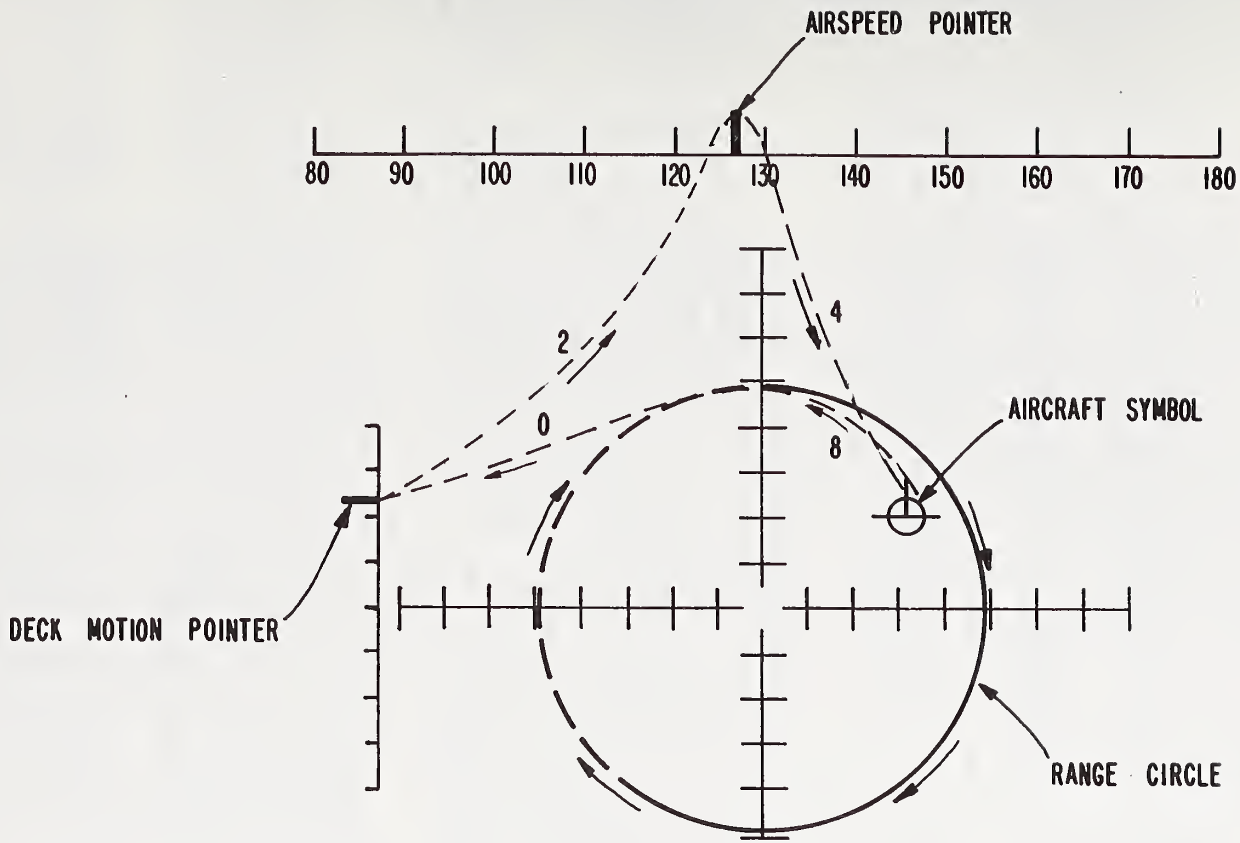


FIGURE 6.2.1 CRT BEAM PATH AND ITS TIMING SEQUENCE. The CRT beam draws, in sequence, the Deck Motion pointer, the Airspeed pointer, the Aircraft Symbol, and the Range circle. The thin dashed lines serve to indicate that the beam is blanked when it jumps from one of the four major display items to the next. The identifying numbers tell when each jump begins. For example, the beam leaves the Range circle at the beginning of the first clock cycle (i.e. at the end of the previous seqeunce of 24 clock cycles), and it leaves the Airspeed pointer at the end of the fourth clock cycle. Paragraphs 6.2.1 thru 6.2.2d give a more complete description of the structure of the CRT trace.

6.2.1a Timing - Reference Dwg. 31E1

The CRT display circuits are controlled by an internal 790 Hz clock oscillator. Twenty-four cycles of the clock are required to completely draw the display once. In order to identify the timing of events within the 24-cycle sequence, we count clock cycles. Counting starts when the CRT beam finishes the RANGE circle portion of the display (this zero-count corresponds to the negative transition of the rectangular wave at pin 5 of plug 1 or of socket 1). The clock runs continuously and a new 24-cycle sequence begins as soon as the previous sequence ends.

6.2.1b Signals

The CRT is controlled by two types of signals; deflection signals that produce deflection in the X and Y directions, and a blanking signal that turns off the beam during intervals when a visible trace is not desired.

6.2.1c Blanking

The CRT beam is blanked during the time that it is traveling from one of the four major display areas to the next. A total of at least 150μs needs to be allowed for the beam to travel to, and settle down accurately into its new location. In addition, the trace is blanked for approximately 8μs near the beginning of each clock cycle. This is done so that the beam will not be visible as it jumps from one part of a local drawing to another part of the same item, as when jumping from the end of the tail of the AIRCRAFT SYMBOL to the beginning of the wing portion of the AIRCRAFT SYMBOL. The 8 μs pulse is timed so that it begins about 3μs before a jump starts. This lead time compensates for delays that occur in the blanking interface circuit.

6.2.1d Detailed Description of CRT Beam Path

The DECK Motion pointer is drawn during the first two cycles of the 24-cycle sequence. The CRT beam is blanked during the first half of the first cycle in order to allow time for the currents in the X and Y-axis deflection coils to change to the values required to drive the beam from the top of the RANGE circle, over to the DECK MOTION pointer location. The visible part of the pointer starts halfway through the first clock cycle. The pointer is composed of three closely spaced parallel lines, each drawn from left-to-right and each taking one-half clock cycle to draw. The top line is drawn first, followed by the bottom line and then the middle line. The beam then jumps to the AIRSPEED pointer, which has the same structure.

The AIRSPEED pointer is drawn during the third and fourth clock cycles, with the first half of the third cycle being blanked, as before. The visible part of this pointer consists of three closely-spaced vertical lines drawn from bottom-to-top. The right-hand line is drawn first, then the left-hand line, and finally the middle. The beam then immediately travels to the AIRCRAFT SYMBOL.

The AIRCRAFT SYMBOL is drawn during the fifth thru the eighth clock cycles. If the low sensitivity glide slope deflection factor (i.e. 30 feet per division) is in use for positioning the AIRCRAFT SYMBOL, then this is indicated to the viewer by representing the aircraft simply as a small circle, drawn during the seventh and eighth clock cycles. In order to make the brightness of the circle about the same as that of the pointers, the circle is drawn twice, once during the seventh clock cycle and once during the eighth clock cycle. These

circles are drawn counter-clockwise from the 3-o'clock position. Wings and a tail are added whenever the more sensitive deflection factor (i.e. 10 feet per division) is used. In this situation the beam is blanked only during the first half of the fifth clock cycle, with the aircraft's tail being drawn from bottom-to-top during the last half of this cycle. The wings are then drawn during the sixth cycle and consist of two left-to-right sweeps, with the second sweep being used only to increase brightness.

The RANGE CIRCLE is drawn once during each of the last 16 cycles of the 24-cycle sequence. The repetitions are needed in order to build up adequate brightness. The first one-third, approximately, of the first circle is blanked in order to allow time for the CRT beam to fully reach the RANGE circle after leaving the AIRCRAFT SYMBOL display. Each repetition starts at the top of the circle and travels clockwise. When the aircraft range is less than one nautical mile, a portion of the circle will be blanked. The fraction of the circle that remains visible is equal to the aircraft range in fractions of a nautical mile (e.g. when 3/4 of the circle is visible, the aircraft is 3/4 mile from the carrier). In order to prevent the circle from being "burned" into the CRT phosphor, the entire circle is blanked out when the aircraft is more than one mile from the carrier.

6.2.2 <u>Waveform Generators - Description of Circuit Board #1/99</u>
Reference Dwgs. 31E1 and 31E2

The primary functions of this circuit board are to generate the control signals that are needed by Circuit Board #100/199 (Display Synthesizer) to generate the CRT display, and to generate the CRT blanking signal.

The heart of Circuit Board #1/99 is a 790 Hz sine wave oscillator. The oscillator is composed of a feedback loop around U1, U2, and U3, while Q1 and Q2 stabilize the sine wave amplitude at approximately ± 8 volts peak. U1 and U2 are in networks that produce unity gain at all frequencies but whose phase shift is a function of frequency. Since inverting amplifier U3 produces close to 180° phase shift at all frequencies of interest, and since a 360° phase shift around the loop is needed for oscillation, then close to 90° phase shift must be provided by the network of U1 and also of U2. This 90° shift provides the quadrature signals that are needed to draw circles on the CRT. U4 is a light emitting diode optically coupled to a cadmium sulfide photo-conductor and is used to adjust the gain of U3 and thus stabilize the sine wave amplitude.

Voltage comparator U5 is used to convert the sine wave into a square wave (has slight dissymmetry) that is then used to drive the digital circuits that follow. The output of the voltage comparator goes to +5 volts when the negative slope of the sine wave reaches 0.00 volts, and goes low when the positive slope of the sine wave reaches approximately +0.2 volts. This hysteresis insures that U5 will not produce unwanted output transitions. The output of U5 drives several circuits. When the output of U5 goes high, the output of U21-a goes low for about 7µs. This pulse blanks the CRT. U21-b introduces a 3µs delay between the output of U5 and the input of binary divider U22. The delay ensures that the CRT is blanked before counter U22 advances to the next segment of the display picture. U27-a and U27-b form a circuit whose output goes low for approximately 6µs on each transition (negative as well as positive) of the U5 output. These double-frequency pulses are used to reset a linear ramp generator on Circuit Board #100/199.

A binary divide-by-eight divider (U22) and a divide-by-three circuit (U23) produce the basic timing that steps the CRT display thru its sequence of 24 clock cycles. The first eight cycles are decoded by U24, whose outputs are low except for the output line selected by the 3-bit input code. The decoded outputs are used as required to provide the gating signals that are needed by Circuit Board #100/199. All outputs of U24 are held low during the last 16 cycles of the sequence by holding pin 11 of U24 (U24/11) high.

The circuit formed by U26-a, U21-d, and U21-c, produce blanking pulses that are one-half clock cycle long; beginning at the start of the first, third, and fifth clock cycles of the sequence of 24. This circuit also produces another blanking pulse about 300 μs long at the beginning of the ninth clock cycle. These four blanking pulses allow a generous amount of time for the current in the CRT deflection coils to make the large change that is needed to produce a major position change of the beam. The output of NAND gate, U30, is the blanking signal and drives the CRT via an interface circuit. Pins 1 and 15 of U30, which are connected to wiring that is external to the circuit board, are protected from voltage transients by resistor-diode networks.

Blanking of the CRT during the RANGE circle display is controlled by the signal from U143/9 (Circuit Board #100/199). This signal is a steady-state +5V when the aircraft range is one or more nautical miles, but becomes a rectangular wave when the range is between zero and one mile. When the range is more than one mile, the +5V control signal allows C25 to charge, via R30, to +5V. This forces the output of U29-d to stay low and thereby blank the entire RANGE circle. But when the range is less than one mile, the voltage across C25 cannot rise above 1.3V because it is periodically discharged by the low voltage portion of the control signal from U143. Because the output of U29-d is now held high, the output of NAND gate U29-c will respond to the signal from U143, allowing the CRT beam to be visible only during the time intervals that this signal is high.

NAND gate U28-d causes the tail and wings of the AIRCRAFT SYMBOL to be blanked whenever the less sensitive glide slope deflection factor (30 feet per division) is used.

Circuit Board #1/99 is powered by the +20V and -20V supplies that are used for the interface deflection amplifier. Integrated circuit voltage regulators are used to reduce these incoming voltages to those required by the circuitry. Voltage regulator U91 produces +14.80 ±.03 volts and -14.8 volts for use by both circuit boards. The +14.80 volts must be accurately set because it is used as a reference voltage for several circuits on Circuit Board #100/199. The 5-volt output provided by regulator U92 is needed only by Circuit Board #1/99.

6.2.3 Display Synthesizer - Description of Circuit Board #100/199
Reference Dwgs. 31E3 thru 31E5

This circuit board uses analog data supplied by the SPN-42 radar system and the waveforms generated by Circuit Board #1/99 to produce the analog X and Y deflection signals for the CRT. A deflection amplifier interfaces the circuit board to the CRT deflection coils. The basic scheme of the circuit board is to use FET switches to select the input signals as required and feed them to a summing amplifier.

P-channel junction field-effect transistors are used extensively on Circuit Board #100/199 as switches. The devices used have a diode connected to the analog input terminal of the transistor. Drawing 31E3 shows how these transistors are used in a typical circuit. The output end of each FET (U101) drives a low impedance load whose voltage is always within 0.1V of ground. When the control voltage (applied to the gate of the FET) is low, then the drain-to-source resistance of the FET is low (approximately 200 ohms) and signal current flows easily thru the FET. But when the gate voltage is driven high, the resistance from source-to-drain is very high and signal current does not reach the output terminal. The FET cannot turn off unless its gate voltage is at least 3V or so more positive than both the analog input and output terminals. By grounding the free end of the auxiliary diode, the analog input voltage at the FET is prevented from going more than about 0.7V positive, thus keeping it well below the +5V gate signal. Scaling resistors, which are always needed between the signal sources and the FET analog input, safely limit the current drawn when the diode conducts. The timing waveforms that control the various FET switches are always shown on the circuit schematics. For example, U101-a lets signal current reach its output terminal only during the first and second clock cycles, and U101-b lets the signals thru only during the third and fourth clock cycles. All control signals for all FET switches are generated by Circuit Board #1/99.

The description of the circuits used on Circuit Board #100/199 flows more smoothly if we start with the output stage and work toward the input stages. Summing amplifiers U161 and U162 produce the X and Y deflection signals used by the CRT. The diode and resistor networks that appear at the output of each summing amplifier provide a first-order correction for non-linearity that is inherent in the CRT itself. The networks cause large output voltages to be attenuated more than are smaller voltages. This tends to correct for the greater deflection sensitivity that the CRT provides at large deflection angles. The summing amplifiers are designed so that the signal delivered to the deflection amplifier can under no circumstance exceed the $\pm$1.5V maximum input signal rating of the amplifier. The 1200 ohm resistors, R171 and R178, are not on the circuit board, but are connected directly to the inputs of the interface deflection amplifier. This is done because the manufacturer requires that the deflection amplifier be connected to a low source resistance whenever power is applied. The trimming resistors, labeled X-Axis Zero and Y-Axis Zero, are used to position the CRT beam at the intersection of the X and Y axis of the aircraft glide slope scale, not at the geometric center of the CRT screen.

The circuits that are used to synthesize the DECK MOTION pointer and the AIRSPEED pointer are basically the same, so only the latter will be described here. The timing signal from pin F of plug #100 (Dwg. 31E3) causes the two-channel FET switch (U101-b) to conduct during the entire third and fourth cycles of the 24-cycle sequence. The signals that produce horizontal deflection are connected via scaling resistors to pin 14 of U101-b. These signals are: a) an analog signal that contains the airspeed data; b) a stable dc offset signal; c) two square-wave signals that when combined give the pointer its width by slightly separating its three vertical strokes. Vertical deflection signals are connected via scaling resistors to pin 11 of U101-b. These signals are: a) a sawtooth wave that is twice the clock frequency, and thus draws four vertical lines during the two clock cycles allotted to the AIRSPEED pointer. One of these four vertical strokes, the first, is blanked by circuits on Circuit Board #1/99, and the remaining three strokes form the visible pointer.

The AIRCRAFT SYMBOL GENERATOR works in the same manner as the pointer circuits; but because it produces a more complicated pattern, more FET switches are required. The position of the center of the AIRCRAFT SYMBOL is determined by the azimuth and elevation (X and Y-axis, respectively) analog voltage from the SPN-42 radar. These signals are applied to the summing amplifiers via U121 during the entire four clock cycles used to synthesize the AIRCRAFT SYMBOL. When the deflection sensitivity is to be 30 feet per division only U121-a is activated, but when the sensitivity is to be 10 feet per division, then both U121-a and U121-b are turned on. The AIRCRAFT SYMBOL itself is drawn with respect to this beam location. The AIRCRAFT SYMBOL is drawn in three separate stages. The tail is drawn first, then the wings, and finally the circle. When the deflection sensitivity for the AIRCRAFT SYMBOL position is 30 feet per division, then the wings and tail are blanked in order to indicate that this deflection factor is in use.

The RANGE GENERATOR produces a large circle on the CRT and also develops a control signal that blanks the circle, or portions thereof, as required. The CRT beam will describe a large circle as long as U141 lets thru the two quadature sine waves that are applied to its inputs. When the analog range signal applied to U143/4 is more negative than -10.3V (i.e. when the aircraft range is more than one nautical mile), then the output of U143 stays high. This causes Circuit Board #1/99 to blank the entire circle. But when the range signal is more positive than -10.3V, the negative-going linear ramp applied to U143/3 will keep the output of U143 low while the ramp is more negative than the range signal. Thus when the range is less than one mile the output of the comparator is a rectangular wave. This waveform will cause Circuit Board #1/99 to blank only that part of the range circle that would be drawn while the rectangular wave is low.

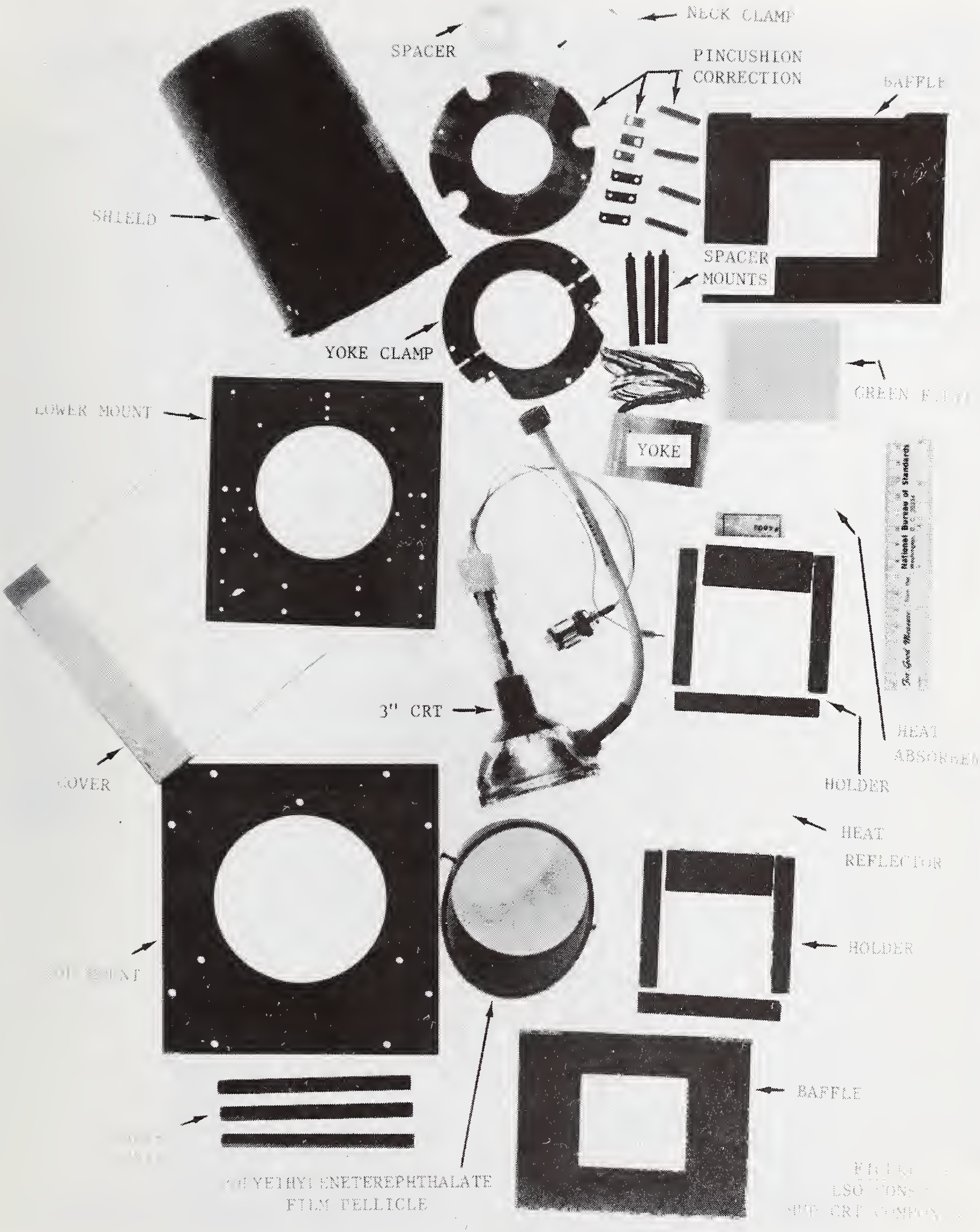
Buffer amplifiers are used to interface the five analog data lines from the SPN-42 radar. A separate amplifier is used for each of the five inputs. The impedance seen by the input signals is at least 300 kilohms, and the amplifier inputs are protected to beyond ±200V dc or peak ac. The output voltage from U183 and U184 is limited so that AIRCRAFT SYMBOL cannot be driven off the CRT screen when the lower sensitivity (i.e. 30 feet per division) glide slope deflection is in use. The gain of each amplifier is tailored to meet the needs of the circuits it drives. All five amplifiers also function as low-pass filters, thereby reducing noise problems.

6.3 CRT Deflection Amplifier and Yoke Assembly
Reference Dwg. 2E, 5E and 8M

The HUD circuit cards, consisting of the Waveform Generator and Display Synthesizer, generate input voltages to the deflection amplifier for the HUD CRT.

The cathode ray tube is a three inch diameter, high intensity HUD type; either 3M51P1M (Thomas) or KC3074P1M (Dumont). This tube has magnetic deflection with electrostatic focusing. The required voltages are shown in Dwg. 2E. The cabling from the deflection amplifier to the CRT yoke is shown in Dwg. 5E. The CRT mounting and yoke layout is shown in Dwg. 8M. The component parts of the CRT, yoke and reticle are shown in Figure 11. the complete assembly is shown in Figure 12. Figure 13 shows the HUD CRT assembly location.

The deflection amplifier for the CRT yoke is a Celco model DA-PP2B with ±1.5 ampere capacity (replacement is DA-PP2N ±2 ampere). The yoke is a Celco BY714S512. Power requirements are +20V DC and -20V DC and 115V AC.


NECK CLAMP
SPACER
PINCUSHION
CORRECTION
BAFFLE
SHIELD
SPACER
MOUNTS
YOKE CLAMP
LOWER MOUNT
YOKE
3" CRT
HEAT
ABSORBER
HOLDER
COVER
HEAT
REFLECTOR
HOLDER
BAFFLE
FILM PELLICLE

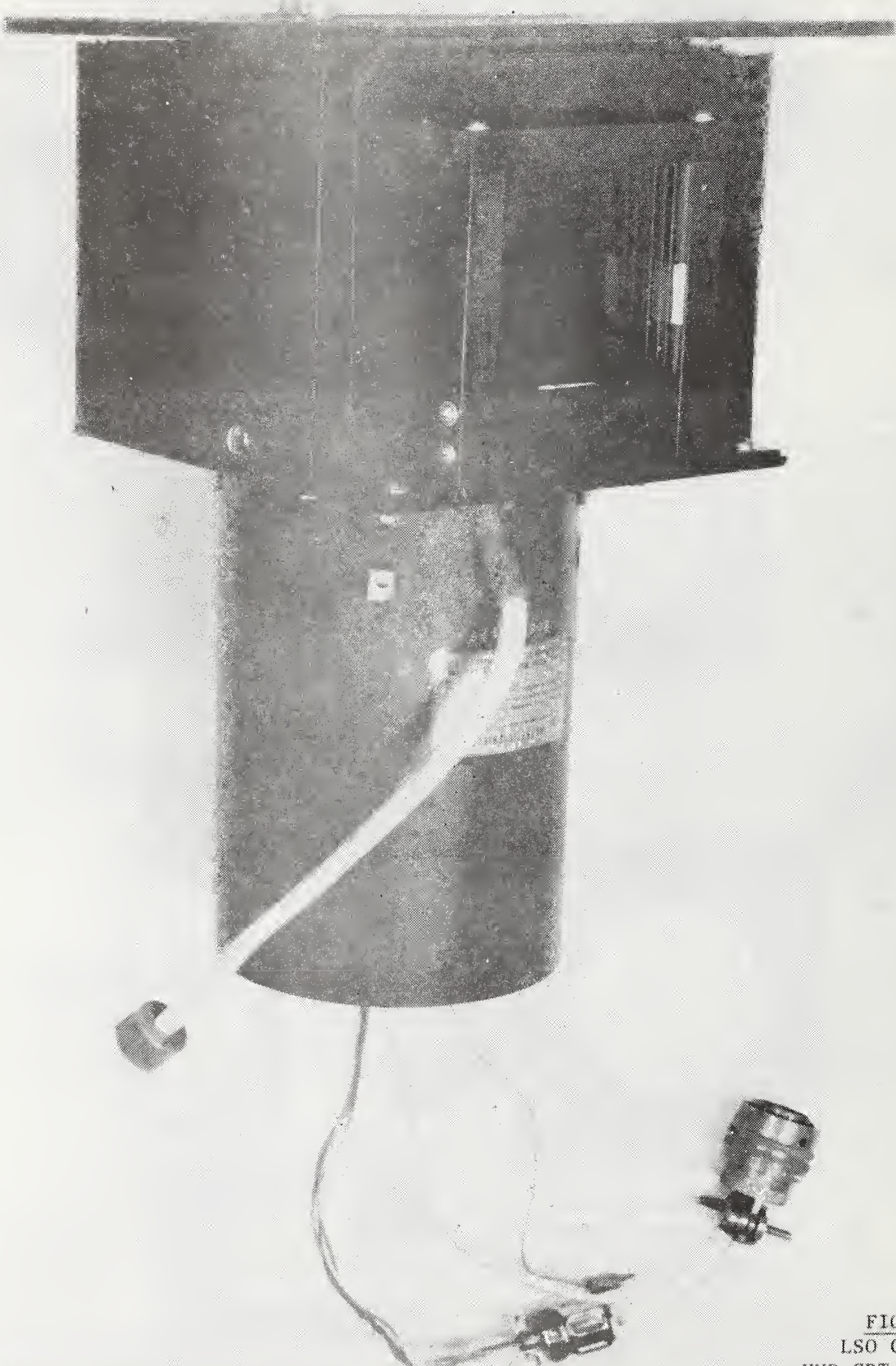


FIGURE 12
LSO CONSOLE
HUD CRT ASSEMBLY

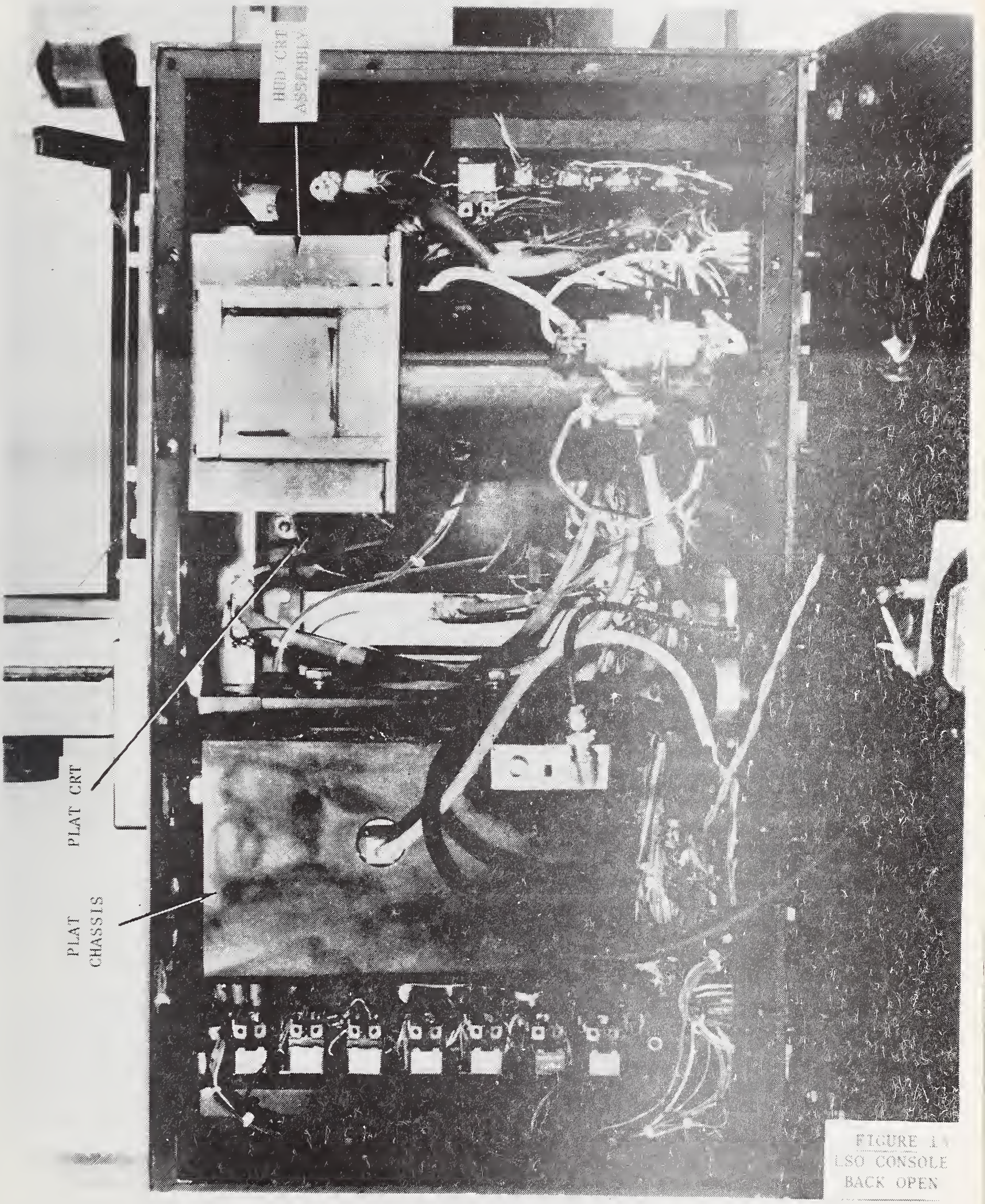


FIGURE 1
LSO CONSOLE
BACK OPEN

Caution: Do not turn on any power unless all terminals on the Amplifier strip are properly connected. At no time should outputs be open circuited while the unit is in operation because the yoke coil is part of the feedback loop. Power supplies are to be turned on and off simultaneously.

The Celco driver is a direct coupled amplifier which operates as a voltage-to-current converter. The amplifier attempts to convert any applied input voltage waveform to an equivalent current waveform through the yoke load. A +1 volt input will result in a +1 ampere output in the yoke. The amplifier contains two identical units for horiztonal and vertical deflection of the CRT. The input voltage should be restricted to $\pm$1.5 volts, therefore, the output is $\pm$1.5 amperes. The output (yoke) current for each amplifier can be monitored at the terminals marked 2 and 8. The optimum source impedance for the amplifier is 1000 ohms. A 1200 ohm resistor is connected across each input section of the amplifier at the amplifier terminal strip. These resistors and the output impedance of the Display Synthesizer described in Section 6.2.3 combine to produce a 1000 ohms impedance at the input of each amplifier section.

6.4 CRT Power and Interface Circuitry: Reference Dwg. 2E, 4E, 5E, 5E1, 7E, 10E, Figure 2, and Block Diagram 2EB

The circuits shown in Dwg. 2E fulfill the voltage requirements for the HUD CRT. The 6.3V AC winding on a Stancor PA8421 power transformer is dedicated to the CRT filament. The other winding is rectified with a one-half rectifier, filtered, and regulated with zener diodes to produce -75V DC for the CRT control grid (G1). This -75V G1 source is gated on only when an output from the CRT is required for displaying information. This gating is done with the circuitry of Q1 and Q2. The gating is controlled by the HUD card, 1/99 Waveform Generator, described in Section 6.2.2. A zero volt input signal to Q1 turns it on bringing its collector close to ground from a negative -75V. The transistor Q2 is an emitter follower with the G1 control as part of the emitter resistor. The emitter resistor is such that the G1 control will vary from -28V to -53V and have a rise time of approximately ten microseconds to bring the CRT on when set for maximum brightness. The emitter voltage is from the -75V source.

The other grid control voltage (G2) and the focus voltage (G4) are obtained from individual dividers and potentiometers from a 600V DC power supply (ARM 036, 8MA). The G2 voltage is set for approximately +480 volts by the 500 kilohm control. The focus (G4) voltage can be varied between +300 and +550 volts with the 250 kilohm control.

The above voltages are generated in the Auxiliary Electronic Cabinet. Drawing 4E (Power Supplies and CRT G1 Gating Layout) shows the location of the components for the CRT filament, G1 and G4 controls. The 500 kilohm control, G2, has been removed from the location shown to the back of the chassis for ease of adjustment and service. These voltages go to the HUD CRT in the LSO Console as part of a nineteen-conductor cable shown on drawing 10E. This cable comes from the lower panel of the Auxiliary Electronic Cabinet (Figure 3) to the LSO Console. Its location at the LSO Console is shown in drawing 5E1. The connectors and conductors are color coded.

The CRT anode voltage is supplied by a CPS Model 5001P unit that is variable from 13kV to 15kV. Output is about 13.8kV for this application. The anode voltage supply is in the Auxiliary Electronic Cabinet and is supplied to the CRT by an RG-8/U coaxial cable. This cable is combined with the four deflection amplifier output cables to the CRT deflection yoke in a single sheath shown in Dwg. 5E. The connectors are color coded to prevent misconnections. The location of the 13kV supply and the deflection amplifier is shown in Dwg. 4E and Dwg. 3E respectively. The cable is connected between the Auxiliary Electronic Cabinet and the LSO Console as shown in Figure 9 and Dwg. 5E1 respectively.

The Monitor of Oscillator and -70V circuit in drawing 7E is necessary in order to protect the HUD CRT from phosphor damage due to a high intensity spot occurring if (1) scanning voltages are lost or (2) the G1 control

voltage is lost. A two part detector circuit is used to monitor these voltages. The CD4001AE detects the absence of the 6 μs pulses from the HUD waveform generators for a period equal to the R-C time constant determined by the 8.2 megohm and 3300pF capacitor or the loss of the -70V (G1) supply. Failure of either of these produces a positive input to the CD4001AE. Its output at #10 goes to ground, turning off Q1 transistor, opening the 800 ohm coil relay (HCM11D), which in turn causes the KRP 11A to open and interrupt the 115V AC to the 13 kV CRT anode supply. This protects the HUD CRT until repairs are made. The source of the 6 μs pulses is the HUD Waveform Generator, #1/99, card for the scanning voltages. The -70V is the CRT maximum negative value of the G1 control voltage. These circuits are on a separate card which is mounted in the card cage containing the two HUD circuit cards, #1/99 and #100/199.

7.0 <u>Console Display Scales - Introduction</u>: Dwgs. 13E, 14E, 15E, 16E, 17E, 18E, 19E, 20E, 21E and Block Diagram 13EB-21EB

The LSO Console contains four scales of the illuminated pointer type for display of Airspeed, Range, Rate of Descent, and Ramp Motion. The inputs for the first three of these scales use analog signals from the ship's SPN-42 radar ACLS system or the SPN-12/44 radar. The ramp motion signal is from the ship's harmonization computers.

Drawings 13EB-21EB show a general block diagram of each scale. The analog signal from the input source goes to an analog to digital converter with binary output. The binary output is decoded from 1 to <u>n</u> where <u>n</u> is the full scale number of a particular scale. The decoder enables the appropriate lamp driver to turn on the lamp corresponding to the binary number. Each number is indicated by a pair of lamps for increased brightness and redundancy. A clock pulse initiates the conversion cycle of the analog to digital converter (A/D) during which time the A/D sends out a "busy" signal on the strobe line to inhibit the decoder during a conversion cycle. At the end of a conversion cycle, the strobe line goes to a "logic low" which enables the decoder. The conversion time (about 200 s) is short in relation to the clock period.

In the case of the Airspeed and Rate of Descent scale, a "trend" lamp was required that would indicate whether the function was increasing or decreasing. This lamp is adjacent to the main pointer lamp and of lesser intensity. It appears behind the main pointer lamp for an increasing function and ahead for a decreasing function. For these two scales the binary data output from the A/D is continuously compared with the A/D output data periodically stored. The comparator provides two outputs which indicate when data is less than or greater than stored data. This provides a sense of direction for changing data. The direction signal is stored in a flip-flop and the gated output provides a signal for the addition or subtraction of one to the data by means of a full adder. The duty factor of this addition or subtraction determines the relative brightness of the trend indicator.

The illumination intensity of the four scales is adjusted by a momentary, center-off, switch that controls a motor driven autotransformer to vary the output of a 14V transformer, Dwg. 6E and 6E3. Each scale has a separate on-off switch and potentiometer control for pointer intensity which are located on the right side of the console, Dwg. 6E.

Drawing 14E, Scale Display Input-Output Wiring, is a composite of the wiring of the scales for indicating the input to the output layout. All analog to digital conversion for the scales is performed by printed circuit cards located in the Auxiliary Electronic Cabinet. The analog input signals are via the 100 conductor cable and the binary outputs go to the LSO Console through the 128 conductor cable to their respective display circuits. These Auxiliary Electronic Cabinet circuits consist of the Airspeed Preamp and Ramp Motion Invert. Amp. Card, Airspeed (J300), Ramp Motion (J200), Range (J100), and Rate of Descent (Sink Rate, J400), cards.

7.1 <u>Airspeed Scale</u> - Reference Dwg. 13E, 15E, 16E and Block Diagram 13EB-21EB

The Airspeed Scale indicates aircraft airspeed by a moving pointer light over a range of from 80 to 180 knots (0 to 100 points). The scale

incorporates a trend light of lesser intensity adjacent to the main pointer to indicate either increasing or decreasing airspeed. Both the scale and the pointer have individual intensity controls as well as separate power sources. These are located on the right of the console with the scale on-off switch.

The input for the Airspeed Display is an analog voltage from the SPN-42 (or 44) ship's radar true airspeed (TAS) or closing airspeed (CLSG) sources. The SPN-42 radar Automatic Carrier Landing System (ACLS) and the SPN-44 radar both have TAS and CLSG airspeed outputs. The desired airspeed for display on the Airspeed Scale is selected by the TAS or CLSG and SPN-42 or SPN-44 switches on the right of the Console. These are fully described in Sections 8.2.1 and 8.2.2. The SPN-44 is a synchro output at the LSO platform. A synchro-to-dc converter is used to convert its output to analog voltage of the same range as the SPN-42. This conversion is covered in Section 7.1.1.

The Airspeed cards, (J500 and J300), are located in the Auxiliary Electronic Cabinet. The input ranges from 3.13V DC for 80 knots to 7.04V DC for 180 knots. Dwg. 13E shows the Airspeed Preamp, U502, with an offset voltage, R515 control, to compensate for this range of inputs. This circuit is necessary since the following analog to digital converter (ADC 898B) operates from 0 to 10V DC. The offset control, R515, and the gain control, R514, are used for calibration of the Airspeed Scale so that it starts at 80 knots for 3.13V DC and covers 100 knots (to 180 knots) when the voltage swings through the range of 3.13V DC to 7.04V DC. The output of the Airspeed Preamp (U502) is applied to the analog to digital converter, card J300, Dwg. 15E (ADC-898B). The control, R300, on the card J300 is preset. The NE555 (U300) timer pulse of approx. 2-3 ms duration and 7 ms period triggers the monostable MV (U301) producing a 1μs pulse to start the analog to digital conversion. The conversion time is approximately 200μs. The timing chart, Figure 7.1, is representative of the series of circuit events.

In Figure 7.1 the timing trace, (1), represents the output of the timer U300 (NE555) at #11 of U302. This output triggers the one shot, U301 (SN74121), to produce a 1μs positive pulse at #6 of U301 to start the A/D conversion, trace (2). Number (3) trace shows the A/D conversion time of approximately 200 μs during which time the pointer and trend lamps are inhibited at the airspeed display scale. Trace (4) shows the levels at #10 and #12 of U307. During the low portion of this, #8 and #11 of U307 are at logic 1. This adds 1 and subtracts 1 to U309 and U310 adders respectively. The resultant is the display time of the pointer ("pointer on"). The high time of trace (4) is the enable condition of U308 into U309 and U310 via U307. This is the trend light "on time". Trace (5) is the level condition of #6 of U302. The high level is the data transfer time from the A/D to the latches (U303, U304). The low level time is the length of the latch U303, U304. In the trace (6) the down level time of 2-3ms inhibits the outputs of U305, U306 via U302, #8. The high level allows U308 to be set or reset depending on the status of #12 or #13 of U306. If data A is greater than latch B (U306, #13), then U308 is set via #3 of U307. If data A is less than B (U306 #13), then U308 is set to the opposite state. Therefore, these circuits continuously compare (U305, U306) binary data output from the A/D (898B) with the A/D output data periodically stored in the latches (U305, U306). The comparator provides 2 outputs at U306, numbers 12 and 13, which indicate when data (A) is less than (A < B) or greater than (A > B) stored data (B). This provides a sense of direction for changing data. The direction signal is stored in the flip-flop U308 (nos. 10, 11) and the gated output U307 (nos. 8 & 11) provides a signal for the addition or subtraction of 1 to the data by means of the full adder U309 and U310. The duty factor of this addition or subtraction determines the relative brightness of the trend light. This can be changed to meet field requirements by adjusting R305 and R304 of U300 (NE555).

The seven binary data lines and the strobe, Dwg. 15E, go to the LSO Console via the 128 conductor cable for the Airspeed Scale of 100 Decoder and Driver Circuitry, Dwg. 16E. A SN74155 2-line-to-4-line Decoder/Demultiplexer operating from the three most significant bits (16,32,64) of the seven binary lines is used in the 3-line to 8-line decoder mode. The SN74155 sequentially strobes six SN74154 units to decode the least significant bits (1,2,4 and 8) into 16 line output for a total of 96 (6 x 16) discrete counts, (0-95).

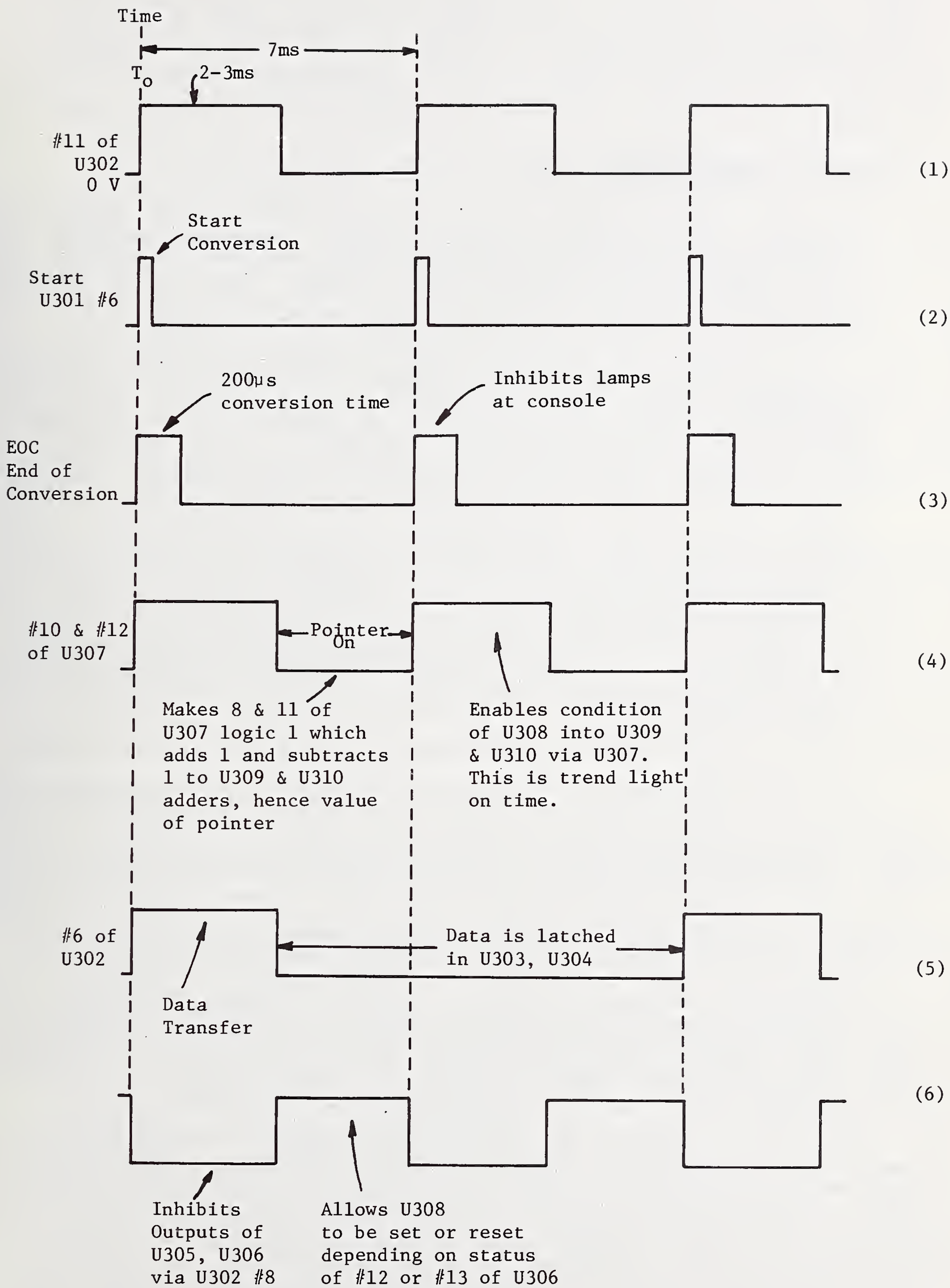


Figure 7.1 Display Scale Timing

Another SN74155 with the 1 and 2 bit input is strobed by the number 7 line output of the 8 line decoder to produce counts 96-98. The circuits consisting of the SN7400, SN7432 and the SN74155, used for the 96-98 count along with the strobe #8, produce count 99 and prevent over ranging. The outputs of the SN74154 units drive UHP400 lamp drivers. Each UHP400 contains 4 individual drivers; therefore, a total of 25 UHP400 units are required for the airspeed scale. Each driver in the UHP400 is of the open collector type and its load is two, type number 715, 5V, 115 mA lamps in parallel for both brightness and redundancy. Voltages below and above the 3.13V DC to 7.04V DC are indicated as 80 knots and 180 knots respectively.

7.1.1 SPN-44 Radar Airspeed - Reference Dwg. 24E1, 24E3, 24E6 and Block Diagram 24EB

The SPN-44 radar is not part of the ACLS system. The SPN-44 radar has both true (TAS) and closing (CLSG) airspeeds available at the LSO platform to drive synchro repeaters. The SPN-44 airspeeds are also displayed on the Airspeed Scale display. The synchro signals must be converted to a DC output in order to drive the Airspeed cards of Section 7.1. This is described in the following paragraphs.

A single printed circuit card contains the circuitry for the conversion from synchro-to-dc output. Synchro-to-dc converters (Astrosystems Mod. No. M1000S-906) are fed from the S1, S2, S3, and reference high and low lines that are available from each synchro. Each converter output is a linear DC signal of 0 to 10 volts for 0° to 360° of synchro rotation which represents 0 to 200 knots of airspeed. The converter output goes to a non-inverting operational amplifier with level-set and gain calibrate controls. The operational amplifier output check points are 80 knots = 3.13V, (144°) 130 knots = 5.09V (234°) and 180 knots = 7.04V (324°). The output of the operational amplifier feeds the Airspeed Scale and the HUD by way of the radar type and airspeed selector switches. Identical circuits for TAS and CLSG Airspeed are used as shown in Dwg. 24E3. As in the use of SPN-42 only true airspeed (TAS) is shown on the HUD display from the SPN-44. The console scale will display either TAS or CLSG data from the SPN-44 as it does for the SPN-42. Therefore, proper operation of the selector switches will give TAS on the HUD and CLSG on the console scale from the SPN-44.

7.2 Rate of Descent Scale - Reference Dwgs. 21E, 18E and Block Diagram 13EB-21EB

The SPN-42 radar ACLS system has an analog output of 0 to 10V DC for 0 to 1912 feet per minute representing the rate of descent (sink rate) of the aircraft as it approaches along the glide slope path to its final touch-down-point. The Rate of Descent card in the Auxiliary Electronics Cabinet and the Scale of 40 Decoder and Lamp Drive in the console convert the analog signal to the Rate of Descent console display. The SPN-42 output is converted from a linear analog voltage to a digital output by the circuit shown in Dwg. 21E. This circuit operates the same as the airspeed circuit, Dwg. 15E, including a trend lamp pointer to indicate an increasing or decreasing rate of descent.

The input varies from 0 to +10V DC which is the range required for the analog to digital converter (ADC-898B), therefore no preamp is required as in Dwg. 13E. Potentiometer R400 is a divider on the input permitting calibration adjustment for the final output of U409 and U410 of 2^6 counts (six binary data lines). Refer to Section 7.1 and Figure 7.1 for the timing and the detailed discussion of the internal circuit functions.

The Rate of Descent console display required 40 discrete levels. Therefore, the circuit, Dwg. #21, was designed for 2^6 bit output, but it incorporates circuitry for only a range of 0 to 39 counts (40 discrete levels). The six binary data lines and the end of conversion (EOC) strobe feed the Scale of 40 Decoder and Lamp Driver in the console, Dwg. 18E, through the 128 conductor cable. The input strobe activates or inhibits the 2Y0-2Y3 section of a 2N74155 unit. The 2 most significant bits of the 6 binary lines (16 and 32 bits) are used to operate the SN74155 in the 2-to-4 line decoder mode. The decoded output strobes two SN74154 4-line-to-16 line Decoders/Demultiplexers where the first four bits (1,2,4,8) are the input

bits from the binary source. These two units produce outputs for counts from 0 to 31. Another SN74155 and a SN7400 (Quad 2-input Positive NAND gate) produce the counts of 32 through 39. The two SN74154 and the SN74155 decoders feed UHP400 Quad 2-input AND power drivers. The UHP400 units turn on console lamps to represent the number of feet per minute an approaching aircraft is descending or ascending. The trend lamp is adjacent to the main pointer but one number less for an increasing rate of descent. The trend lamp is one number greater than the pointer for a decreasing rate of descent.

7.3 Range Scale - Reference Dwgs: 19E, 20E and Block Diagram 13EB-21EB

The console Range Scale operates when the aircraft is 3 nautical miles or less from the touch-down-point. It has a resolution of 0.1 nautical mile per scale division for the three mile scale. The SPN-42 range buffer has an output of 0 to 30V DC for three miles. The Range card is located in the Auxiliary Electronic Cabinet. Referring to Dwg. 19E, this input is applied through the R109 gain control to U104. The U104 circuit is a load isolation amplifier. The signal is not inverted in U104 and its output goes to the analog to digital converter, A/D, (ADC-898B) via R100 which is set to full input to give a voltage swing of 0 to 10 volts when R109 has been correctly set. Analog to digital conversion of the input signal is started by a short pulse from the timer U100 (NE555) applied via the SN7400 unit to the A/D at terminal number 3. The resultant A/D output is five binary output data lines. The SN74L85 4-bit magnitude comparator and the SN7400 gates are used to detect when the aircraft is less than 0.5 nautical miles from the carrier touch-down-point. Originally, this was to be used in conjunction with the deck becoming closed at 0.5 mile, or less, range to initiate a warning to the LSO. Initial field tests indicated this feature was not necessary and it is not operating on the Ranger installation.

The five binary output lines and the end of conversion (EOC) strobe go to the LSO console through the 128 conductor cable. The Range Scale of 30 Decoder and Lamp driver circuitry in the LSO console is shown in Dwg. 20E. As in the other scales, the end of conversion strobe inhibits the scale pointer lamps during conversion time to prevent an erratic display as the binary bits shift. Two SN7415 4-line-to-16 line Decoders/Demultiplexers are used to decode the five binary data lines and drive the UHP400 lamp drivers. Output 30 and 31 both drive the same pointer lamp. The input control, Dwg. 19E, R109, is adjusted for pointer action of 0 to 30 on the display scale for 0 to 3 nautical miles of range. When the range is greater than three miles, the pointer remains at the maximum value on the scale.

7.4 Ramp Motion Scale: Reference Dwg. 13E, 17E and Block Diagram 13EB-21EB

The source for the Ramp Motion signal is from the ship Harmonization Computer (SFHC) and not from the SPN-42 radar, the source for the other scales.

A momentary toggle switch is located on the right control panel of the console. In the normal position of this switch, this scale displays the sum of the ramp displacement due to the sea and any fixed displacement due to the ship's trim. In the momentary position of this switch, ship trim is separately displayed on the scale. Ship's trim is defined as the deck position relative to the true horizontal independent of sea action. If the ship has bow-down trim, a resulting ramp above the horizontal exists and there is a lesser dynamic travel of the ramp before it reaches +20 feet on the scale and a greater travel to reach - 20 feet. Care must be taken in the adjustment of the offset (R206) and gain (R200) controls in order to give a true ramp plus trim or trim only display on the scale. The Ramp Motion signal covers the range of ±10V DC for ±20 ft of ramp motion (including trim). This signal is the input to the Ramp card in the Auxiliary Electronic Cabinet. This signal is inverted with a unity gain operational amplifier, Dwg. 13E, before the analog to digital converter. The inverted ramp motion signal feeds the analog to digital converter, Dwg. 17E. The ±10V DC change, (Dwg. 13E), is digitized by the analog to digital converter, A/D, (ADC-898B), to produce 6 binary bits. The gain control (R200) and offset control (R206) are used for calibration and operation of the A/D with a ±10V DC input. The process is started with the U200 (NE555) timer. The six binary data lines

and strobe signal go to the Scale of 40 Decoder Lamp Driver located in the LSO console for the Ramp Motion Scale, Dwg. 18E.

The operation of the Ramp Motion display circuitry is the same as for the Rate of Descent Scale of 40 discussed in Section 5.3.3 except for the following details. The Ramp Motion card incorporates an offset so that the zero count of the decoded binary output represents the high ramp, +10V DC signal, and is displayed as +20 feet on the top of the Ramp Scale. When there is no ramp motion (zero volts), the count is number 20 and the scale display is zero feet. A low ramp of -9.5V DC is -19 feet on the scale and count number 39. Therefore, the scale is capable of a range of +20 feet to -19 feet of ramp motion.

The most dangerous ramp position during landing operations is a high ramp from +10 feet to +20 feet. This range is indicated by a red filter on the scale. A high ramp is much more dangerous than a low ramp since the latter means a hard landing and less danger to the pilot and aircraft, while the former may mean a ramp strike.

8.0 Console Indicators

This section covers a group of console lamps other than the display scales. The lamps indicate other information for aircraft landing operations. These indicators are all located on the front of the console except the MOVLAS which is on the left side. Information is presented by lamps being on, off, flashing, or by alpha-numeric displays.

8.1 Deck Status - Reference, Dg. 6E1 and Block Diagram 6E1B

This section covers three indications that are extremely important during landing operations involving the condition of the deck and the wave-off signal transmitted to the aircraft by the LSO. Each indicator is covered separately.

8.1.1 Deck Open - Reference, Dwg. 6E1

The "Deck Open" indicator means the deck has no obstructions on it to prevent landing and all recovery systems are ready to recover the aircraft in the glide-slope approach path. This condition is indicated to the LSO by the "Deck Open" signal at the console.

The "Deck Open" signal is a 115V AC signal from the ship when all conditions are correct. This signal goes to the Wave-Off and Deck Status Card in the Auxiliary Electronics Cabinet, Dwg. 6E1. The 115V AC signal closes the relay, K6, which activates the two 12V AC lamps of the Deck Open indicator located in the upper left corner of the console. A green filter is used in front of these lamps. Two lamps are used for redundancy. The Deck Open signal will remain on as long as 115V AC is applied to relay K6. A rheostat located on the right of the console, Figure 2, labeled "Lamps" in the Deck Status section of the front panel controls varies the intensity of the Deck Open indicator. This control also sets the intensity level for the Deck Closed signal covered in section 8.1.2. This intensity control will control the brightness of these indicators for both day and night operations.

8.1.2 Deck Closed - Reference, Dwg. 6E1

The aircraft recovery deck is closed when recovery equipment is not ready to recover the aircraft in the glide slope approach path or when obstructions are present. This is indicated to the LSO with a "Deck Closed" lamp display in the left end of the Airspeed Scale module. The Deck Closed (red) and Deck Open (green) indicators are adjacent to each other.

The "Deck Closed" signal is a 115V AC signal from the ship when all conditions are not correct. This signal goes to the Wave-Off and Deck Status card in the Auxiliary Electronics Cabinet, Dwg. 6E1. The 115V AC signal closes the relay, K5, which activates the two 12V AC

lamps of the red Deck Closed indicator in the LSO console. The deck closed lamp will remain on until the 115V AC signal is removed indicating the deck is not closed. The intensity of this indicator is controlled by the same rheostat as used for the Deck Open lamps.

8.1.3 LSO Wave-Off (FLOLS Wave-Off) - Reference Dwg. 6E1

The LSO uses a hand held "pickle switch" to initiate a Fresnel Optical Landing System (FLOLS) wave-off to signal the pilot on the glide-slope landing approach not to land. The FLOLS wave-off flashes red lights on the fresnel lens system which are visible to the pilot. The LSO needs to know that the FLOLS wave-off has been triggered, therefore, a LSO wave-off indicator is located just below the Deck Open and Deck Closed lamps in the Airspeed Scale module.

The LSO wave-off signal to the Auxiliary Electronics Cabinet is a 28V DC signal from the FLOLS wave-off. The 28V DC signal activates the 24V relay, K3, Dwg. 6E1. This relay removes the ground connection of the LSO Wave-Off Flash Timer located in the Airspeed module in the console. The flasher consists of the U1 (NE555) timer of approximately 360 counts per minute and the U2 (SN7474) flip-flop as a divide-by-four circuit for 90 flashes per minute. The output of the flip-flop (U2) triggers three of the four sections of the UHP400 lamp drivers. Each section has a 12V lamp as its load and these simultaneously flash at 90 flashes per minute to indicate the initiation of the FLOLS wave-off signal.

8.2 ACLS Radar Status - Reference, Dwg. 6E1, 6E2, and Block Diagrams 6E1B and 6E2B.

The principal source of display signals for the LSO console is from the Automatic Carrier Landing System (ACLS), SPN-42 radar. Certain operational indicators pertaining to the automatic landing of aircraft regarding the ACLS performance are indicated at the console for the LSO's use.

8.2.1 Radar Selection Switch - Reference, Dwg. 6E2

The selection of either the SPN-42 or SPN-44 radar is indicated on the LSO Console in the right end of the Airspeed Scale module by two 12V lamps.

The SPN-42 and SPN-44 ship's radar both supply airspeed information for the LSO Console display. A Radar Selection Switch is located on the right side of the console to select either the SPN-42 or the SPN-44 radar by the action of the relay, K1, in the Auxiliary Electronic Cabinet. The airspeed input to the airspeed card is from the SPN-42 source when the switch is in the SPN-42 position. The 12V lamp in the upper right hand corner of the console indicates SPN-42 selection. In the SPN-44 position the switch closes the relay, K1, and the SPN-44 airspeed source is used and indicated by the SPN-44 (12V) lamp above the SPN-42 lamp.

8.2.2 Airspeed Selection Switch: Reference Dwg. 6E2

The Airspeed Selection Switch is located on the right side of the console. It is a two position switch for selecting either true (TAS) or closing (CLSG) airspeed. Both of the radars have two airspeeds available as outputs. In the TAS position of this switch the relay, K2, in the Auxiliary Electronic is open and the true airspeed from the selected radar is displayed on the Airspeed Scale. The TAS lamp at the right end of the Airspeed Scale comes on. In the CLSG position, relay, K2, is closed and the closing airspeed goes to the Airspeed Scale. The CLSG lamp comes on above the TAS lamp and the TAS lamp goes off. Note that the wiring of relays, K1 and K2, is such that their operation only changes the Airspeed Scale display to either TAS or CLSG. True airspeed only, is shown on the HUD display.

8.2.3 Lock-On and Mode

The Automatic Carrier Landing System (ACLS) has a number of discrete signals indicated at its console relating to its operation. Certain ones are displayed at the console for the use of the LSO during landings. They operate as described in the following discussion.

Lock-On: Reference, Dwg. 6E2

The Lock-On indicator conveys to the LSO operator that the ACLS equipment is coupled to the aircraft of interest and the results of the coupled data regarding the approach is being used to attempt a fully automatic aircraft recovery.

The ACLS lock-on signal of 28V DC activates the relay, K3, (Dwg. 6E2) in the Auxiliary Electronic Cabinet. The relay, K3, turns on the 12V lamps of the console Lock-On indicator.

Mode I - Reference, Dwg. 6E2

The Mode I operation using ACLS is a completely "hands-off" landing with the pilot acting as a monitor. The ACLS equipment is "locked-on" and complete instructions are transmitted to the aircraft controls to automatically fly the plane from Lock-On to the touch-down-point and recovery.

A 28V DC signal from the SPN-42 closes relay, K4, (Dwg. 6E2) in the Auxiliary Electronic Cabinet. When relay K4 is closed, the 12V lamp indicates Mode I operation on the console.

Mode II - Reference, Dwg. 6E2

The partial control of the aircraft by the ACLS system is defined as Mode II. This is basically an instrument landing system operation.

The 28V DC Mode II signal from the SPN-42 activates the relay, K5, (Dwg. 6E2) which turns on the Mode II indicator at the LSO console.

Mode III - Reference, Dwg. 6E2

The Mode III operation indicates a "talk-down" landing of the aircraft. Even though a Lock-On is obtained with the aircraft, data obtained for control or response to control is unreliable. Therefore, the pilot is flying the plane to make a non-ACLS landing.

The SPN-42 sends out a 28V DC Mode III signal to close the relay, K6, (Dwg. 6E2). Relay K6 turns on the 12V lamp of the Mode III console indicator.

8.2.4 ACLS Wave-Off: Reference, Dwg. 6E1

The ACLS equipment initiates a wave-off signal to the aircraft making a landing approach when it determines from its internal checks and aircraft control that its data is not reliable. An ACLS wave-off is not necessarily a final wave-off.

The ACLS wave-off 28V DC signal from the SPN-42 closes relay, K2, Dwg. 6E1. Relay K2 removes the ground of the ACLS wave-off flash timer. This circuitry is located in the ACLS display status module at the console. The U100 (NE555) timer operates at approximately 360 flashes per minute. A flip-flop, (U101), is used to divide by two for 180 flashes per minute. The flip-flop output triggers the three sections of the UHP400 lamp driver to operate the three ACLS wave-off lamps simultaneously. A blue filter is used for the ACLS wave-off display.

8.2.5 Warning: Reference, Dwg. 6E2

The SPN-42 radar system automatically generates an ACLS wave-off when the system information does not satisfy certain internal checks. Therefore the warning display, which was to be activated by any one of these fail-to-check conditions, was considered superficial and is not used in this installation aboard the Ranger.

8.3 MOVLAS Indicator: Reference Dwg. 25E

A MOVLAS repeater is incorporated on the left side of the LSO Console. The Manual Operated Visual Landing Aid System (MOVLAS) is used when the Fresnel lens landing system is inoperative. The repeater is driven from the ship's MOVLAS source and repeats what the pilot sees for the LSO station. The datum bar is supplied by 6V AC for the green indicators. The "meatball" indicators are vertical amber lamps except for the three lower lamps, which are red, indicating danger. The ship's +5V DC is common to one side of these lamps and the proper amber or red lamps are turned on by the MOVLAS controller grounding the other lamp terminal. A dual control potentiometer is used to adjust the datum bar and "meatball" intensity. The system has a separate on-off switch to turn it off when not in use. These controls are on the right side of the console.

8.4 Aircraft Type Designator - Reference, Dwg. 22E, 23E, and Block Diagram 22EB

Ten different types of aircraft may be recovered aboard the USS Ranger. Each Aircraft is designated by one alpha and one numeric character in Primary Flight. No second numeric character is required. This same display is shown on the LSO Console.

The aircraft type is designated by a +24V DC signal on a single conductor with a common return for all signals. Each aircraft type signal comes to the Aircraft Designator Card, (Dwg. 22E), in the Auxiliary Electronic Cabinet and is converted to a 4-bit code. As an example: a 24 volt signal, from the "A 3" aircraft type, at #1 of U1 causes the gate to conduct. Terminal #2 goes to ground to produce a logic "0". Diodes are coupled from the #2 output of U1 to the proper input of two 4-line decoder/drivers (SCS Model 1005) for seven bit output. The required input to the alpha (A) driver is logic 1010 and 0011 is the logic for the numeric (3) driver. The resultant seven bit output is 0001000 for "A" and 0000110 for "3" respectively. The two seven bit outputs turn on the proper segments of two seven segment incandescent lamp displays to indicate the A3 aircraft. A complete truth table for input and output is contained on Dwg. 22E. Two spare lines and gates have been provided for possible additional aircraft. A new aircraft can be indicated by adding diodes to the proper output lines on the card using the truth table. The 4-line to 7-line decoder/driver and alpha-numeric character display circuits are in the ACLS module of the console.

The presence of an aircraft, a +24V DC signal on one of the ten lines, is detected using the "OR" circuit of U1 and U2 and relay, K1, shown in Dwg. 23E. When any section of U1 or U2 conducts, relay, K1, closes to switch +4V DC power to the alpha-numeric aircraft type console indicators. Therefore, if no aircraft is being recovered, Primary Flight does not activate a single line to the U1, U2 "OR" gate, K1 remains open, and no segment of the aircraft display characters can be on regardless of the decoder/drivers output. This prevents partial or erronous displays.

The source of power to the relay K1, for the aircraft alpha-numeric characters, is from the Q3 and Q4 circuits with a maximum of 4 volts and a minimum of 1.26 volts available. The display intensity control is a 500 ohm, 2W rheostat located on the right side panel of the console and labeled Aircraft-Wind Intensity.

8.5 Wind Speed Card: Reference, Dwg. 24E4 and Block Diagram 24EB

Wind speed across the carrier deck is important and critical for the recovery of aircraft. Wind speed and direction are transmitted to the LSO station in synchro form. These synchro voltages are used as the input for the wind speed indicator and are fed into the synchro-to-dc converter (Mod.

no. M1000S-906) located in the Auxiliary Electronic Cabinet. The converter card produces 0 to +10 volts DC output for the total range. A noninverting operational amplifier (U1) with level set (R1) and calibrate (R4) controls supplies the analog to digital converter (A/D) and display circuitry located in the LSO console. The A/D (ADC-898D) converter is used in the analog input to 2 digit BCD output mode. The conversion is started by the U1 (NE555) free running timer of approximately 7 ms period having a 12μs pulse width. The U4 (1/4 of 7400) inverts this for the start pulse. The resultant A/D output is 2 digit BCD.

The 2 BCD outputs drive two Model 1005 decoder/drivers (U2 and U3), to convert each 4 line BDC to 7 line output respectively. The output of the two decoder/drivers, U2 and U3, turn on the respective tens and units wind speed numeric displays. Each numeric character is seven incandescent lamps arranged in a seven segment numeric character format. A maximum of 99 knots can be indicated for the wind speed. The operating wind speed for aircraft recovery is, usually, 30 knots.

The A/D converter, timer, decoders, and the two numeric indicators are located in the console ACLS box. A lamp intensity control, 500 ohms, 2W, is used to control the light output to accommodate day and night operations. This control is the same one used for the aircraft type designator and wind angles display, Dwg. 23E. Its setting controls the output voltage supplied for both the wind speed and angle from transistors Q1 and Q2. The whole display of ACLS, Wind Angle and Speed and Aircraft Type can be turned off by the on-off switch (Dwg. 6E) adjacent to the ACLS intensity control on the right side of the console.

8.6 Wind Direction: Reference Dwg. 24E5, 23E and Block Diagram 24EB

Wind angle magnitude, and either port (P) or starboard (S) direction, are critical factors to be displayed at the console. The original S1, S2, S3 and reference synchro lines for wind angle feed a synchro-to-dc converter (Mod. No. M1000S-906) for wind angle conversion to a DC output voltage. This circuit is in the Auxiliary Electronic Cabinet. The M1000S-906 is used in the ±180° mode in order to reference the wind angle to the centerline of the angled landing deck of the carrier. A reference adjustment control, (R12), sets the converter output for zero as referenced to the angled deck. The angled deck of the Ranger is 10° to port of the center line of the carrier or at 350°. Therefore, the converter is set at zero output for 350° synchro rotation. An absolute value circuit (U2, U3) converts the ±5V DC signal for ± 180° to 0 to +5V DC in order to indicate the magnitude of the angle. An analog to digital converter, (ADC-898D), timer (U5, NE555), decoder/drivers (U6, U7: Mod. 1005) and two numeric display characters are located in the ACLS console box. These circuits function the same as those for wind speed, as described in section 8.5, to display tens and units of wind angle magnitude. The wind angle displays up to 50° maximum, either port or starboard, for a zero to five volt change in the absolute circuit. Related to the angled deck as the required reference, this is ± 50° of magnitude. Landing operations are usually conducted within ± 10° of the centerline of the angled deck.

The direction of the wind, either port or starboard, is part of the wind angle display. The output of the synchro-to-dc converter of Dwg. 24E5 feeds a "zero level" detector (U3) shown on the Dwg. 23E. The zero level detector produces a plus output for a plus input and a ground (zero) output for a negative input. Therefore, it is used to sense port or starboard output from the ± 180° converter. This circuitry and the following gating of U4 is used to drive relays which turn on the respective P or S indicators. A positive input to U3 is a starboard signal and a negative input to U3 produces the port signal. The P/S alpha character is also a seven segment incandescent type. Coding for P/S is done by the relays K2 and K3 since only two characters have to be displayed and they have several segments in common in their format.

The on-off and intensity controls of this display are covered in Section 8.5.

9.0 PLAT and Intercommunication Units

Plat Monitor: Reference Dwg. 1E and Block Diagram 1EB

A Conrac ENA 9/N TV monitor was used in the LSO console for the Pilot Landing Aid Television monitor (PLAT). This displays the information from the TV camera mounted in the deck that monitors the glide-slope approach of the landing aircraft. The picture tube and circuit chassis were separated in order to physically locate them in the available space of the console. Remote controls were brought out to a PLAT control panel on the left side of the console. The circuit changes for this are shown in Dwg. 1E. A parallel power on-off switch was added with a two wafer 6 pole-two position rotary switch to select either internal or remote operation. For remote operation, an external brightness, contrast, vertical and horizontal hold controls were added. The two hold controls are screwdriver adjustments on the original chassis. They are included on the left side console panel in addition to the normal chassis controls of brightness and contrast for the operator's use. The arrangement for remote operation permits the monitor to be removed and switched back to normal internal controls for testing and servicing.

The composite television input for the PLAT comes into the LSO console by a RG-90/U coaxial cable on the bottom of the LSO console as shown in Dwg. 5E1.

Intercommunication Units

The LSO operator has two forms of communications available at the console. An outlet for a radio phone handset is mounted to the right and below the TV panning head which supports the console. The radio handset is used to communicate with the pilot in the aircraft glide-slope approach. The radio handset along with the "pickle switch" hook to the front bar at the base of the console.

An Intercom, 21MC Unit (LS-458/SIC), is mounted in the right side of the LSO console. This is a standard two station unit with all connections brought out to a plug on the bottom of the console so this unit can be connected to the ship's intercom system. This unit is wired so that the LSO can communicate with the Primary Flight (Pri Fly) Center and the Carrier Traffic Control Center (CATCC). The details for the wiring of this unit are covered in the NAVSHIPS 365-2822, Technical Manual for Intercommunication Station LS-458/SIC, December 12, 1962.

10.0 Miscellaneous

10.1 LSO Console, Auxiliary Electronic Cabinet and Ship's Source Wiring: Reference Dwg. 11E and Figure 2

The Dwg. 11E shows a composite of cable connections from the ship's input sources to both the Auxiliary Electronic Cabinet and any direct source to the LSO Console. The interconnect cables between the Auxiliary Electronic Cabinet and LSO Console are shown. The Auxiliary Electronic Cabinet is located one level below the flight deck in a small room almost directly below the LSO platform. The LSO escape passage hatch opens into the back of the Auxiliary Electronic Cabinet room.

Two J-boxes supply input signals to the Auxiliary Electronic Cabinet. These are located on the outer bulkhead of the room. The distance from the signal J-boxes to the Auxiliary Electronic Cabinet is only a few feet.

The Signal J-box is the input terminal box for all of the ship's signals to the Auxiliary Electronic Cabinet except the synchro signals which are in a separate J-box. These are the ACLS SPN-42, Ramp Motion, Wave-Off, Deck Open-Closed and Aircraft Type Signals. A single, 100 conductor, cable conducts these signals to the Auxiliary Electronic Cabinet.

The Auxiliary Electronic Cabinet contains the circuitry for converting the input signals to the proper format to drive the displays of the LSO Console. A 128 conductor cable transmits these signals between the auxiliary electronics and LSO Console. The 128 conductor, CRT Power Control, Console Power Control and Power, CRT Defl. Amp. and 13 kV cable are about 30 ft in length and couple the Auxiliary Electronic Cabinet to the LSO console on the LSO deck platform. These cables are combined in a single flexible bundle

with the following cables: (1) output cable from the Intercom 21MC unit (LS-458/SIC), (2) composite Plat Input (RG90/U), (3) MOVLAS Repeater Input, (4) a dry nitrogen supply line (not used on the present Rnger installation), (5) Ship's Radio System, and FLOLS Wave-off and Cut Lights. This bundle of cables is secured to the LSO Console mount and travels up and down as the console is raised and lowered. All input-output cable plugs and sockets come into the base of the LSO console. These plugs and sockets are color coded and mechanically keyed to prevent improper assembly at both the Auxiliary Electronic Cabinet and the LSO Console.

The radio handset and LSO "pickle switch" for LSO Wave-Off attach to their respective plugs just below the LSO Console.

10.2 <u>Junction Box Wiring Requirements</u>; Reference Dwg. 12E

The Signal J-box connections are indicated in this drawing. All input and other cables as well as each terminal block is coded for ease of circuit tracing and maintenance. For example, consider the Deck Open signal; it comes in from the ship on RB381 and RBB and terminates on the terminal board STB2 lug 15 (STB2-15) and STB2-19 respectively. The high signal, STB2-15, goes to the Auxiliary Electronic Cabinet via the 100 conductor cable on No. 20 and STB2-19, which is the return, goes to 100-21. Likewise, the SPN-42 true airspeed (TAS) comes from rack 14 terminal board 31 terminal No. 9 (14TB31-9) and is connected to the terminal block in the Signal J-box designated by STB1-10. From STB1-10 the true airspeed goes to the Auxiliary Electronic Cabinet by the #100-11 conductor. The ground return for this is #100-6 to STB1-3 to TB31-8. Dwg. 12E does not show all of the detail markings; these markings are in the Signal J-box on each lead and terminal board.

The Synchro Signal J-box handles the synchro signal input lines from the following synchros; wind speed, wind direction, and SPN-44 radar true and closing airspeed lines. A single cable from this box conducts these input signals to the synchro-to-dc converters in the Auxiliary Electronic Cabinet.

The Synchro J-box input leads, terminal blocks and output leads are all coded similar to that used for the Signal J-box. The cross reference, Dwgs. 24E, 24E4, and 24E5, shows the synchro inputs to the auxiliary box via the synchro-to-dc converter cable.

10.3 <u>Console Plug Layout</u> - Reference Dwg. 5E1

This drawing is useful for set-up and trouble shooting. The drawing is a top view of the bottom of the LSO Console. It shows the location of all the input and output plugs or sockets. The two "pickle switches" for the LSO wave-off and the radio handset locations are external for the Ranger installation. They are mounted just below the console. It was considered unnecessary for them to come into the box and go out since their use was not related to the internal workings of the console.

10.4 <u>Head-Up Scale, Console Scales & Console Scale Pointer Supplies</u>
Reference Dwg. 6E, Block Diagram 6EB, Layout Dwgs. 4E and Figure 3.

Several different power sources, both AC and DC, are required for panel, scale, scale pointer, and status display illumination. Dwg. 6E shows the details of these. All of these supplies are located in the Auxiliary Electronic Cabinet and have their controls on the LSO Console.

A 12 volt transformer is used to illuminate the ACLS lamps of Lock-on, Mode I, II or III, and the deck status of either Open or Closed Deck. These functions are shown in Dwg. 6E1 and 6E2 and discussed in Sections 8.1 and 8.2.

A 6.3 volt transformer is dedicated to illuminate the three side panels consisting of HUD, PLAT and Deck Status. This is also shown in Deg. 8E. A 2 ohm, 12.5 watt, rheostat in series with fixed resistors controls the intensity of these panel control labels for night and low light levels. An on-off switch is included to turn the illumination off during daylight operations since the control functions are labeled in white on a black panel.

The HUD scale illumination is controlled by a motor driven variable autotransformer through a slip-clutch that functions when the autotransformer is driven to either extreme. The autotransformer controls the output of a 28 volt transformer used for the HUD scale lamp. Also see Dwg. 6E3.

A similar motor driven autotransformer controls a 14 volt transformer to illuminate the four console display scales of Airspeed, Range, Rate of Descent, and Ramp Motion. Also see Dwg. 6E3.

A 7V DC supply is used for pointer illumination of these scales (Lambda Model LCS-B-01). This supply furnishes the voltage for both the trend and the non-trend pointers as shown in the output circuit. The four scales have individual pointer intensity controls and on-off switches. Certain conditions may not require a scale display so each can be turned off separately.

The ACLS SPN-42 information of Lock-On, Mode I, II and III has a separate on-off switch and a 50 ohm, 25W, intensity control. The on-off switch is a double pole type; the other side controls the Wind and Aircraft Displays discussed in 10.4. These controls are detailed on drawing 6E1 and 6E2.

10.5 Wind and Aircraft Type Power Supplies - Reference, Dwg. 23E

The wind speed and magnitude synchro-to-dc converters and the SPN-44 true and closing airspeed synchro-to-dc converters require +15V DC and -15V DC. The circuits for obtaining these voltages are shown in Dwg. 23E. The voltage regulators VR4, type 7815, and VR3, type 7915, are used to obtain the +15V DC and -15V DC from the +20V DC and -20V DC supplies in the Auxiliary Electronic Cabinet for the SPN-44 true and closing synchro-to-dc converters described in Section 7.1.2, Dwg. 24E3.

Separate regulators, VR2 (type 7815) and VR1 (type 7915), generate +15V DC and -15V DC from the +20V DC and - 20 VDC for the wind speed and wind angle synchro-to-dc converters covered in Section 8.5 and 8.6, Dwgs. 24E4 and 24E5. The +15V DC and -15V DC from VR2 and VR1 are also required for the analog-to-BCD converters, (ADC-898D), that drive the wind angle and speed displays. These converters are located in the ACLS module with the decoder/drivers for each alpha-numeric display.

The above described circuits along with the P/S detector, "any aircraft detector" and +4V DC for aircraft and +4V DC for wind displays are all contained on a single card located in the Auxiliary Electronic Cabinet.

10.6 Card Cage Layout in the Auxiliary Electronic Cabinet
Reference, Dg. 24E6

This is a reference layout showing the location in the Auxiliary Electronic Cabinet of nine printed circuit cards for the four display scales, the aircraft type indicator, and the wind speed and wind angle indicators. This information is useful when servicing or testing the equipment.

10.7 Synchro-to-DC Converter Layout: Reference, Dwg. 24E1 and 24E2

These two drawings apply to the synchro-to-dc converter cards of SPN-44 true and closing airspeed and wind angle and speed for physical location of parts and construction. They supplement the detailed circuit diagrams for these functions in drawings 24E3, 24E4 and 24E5.

10.8 Miscellaneous Connections: Reference, Dwgs. 9E, 9E1, and 9E2

The drawing, 9E, is the layout of one of the several upper to lower chassis connectors in the Auxiliary Electronic Cabinet. Also two terminal boards are used for connecting input and output voltages or signals within the chassis or to the LSO Console. The drawing 9E1 is a layout of these terminal boards. Both of these layouts are useful for servicing of the equipment.

Two terminal boards are located within the LSO Console on the bottom. These are used as distribution points of certain voltages. They are shown in drawing 9E2 with the voltage on each terminal. These are in addition to the input plugs and sockets shown in drawing 5E1.

11.0 Simulator - Reference Dwg. 26E

The circuitry in drawing 26E has been built into a portable simulator test box. The output signals incorporated in this simulator test box can be used to test the LSO Console operation without the SPN-42 output or other outputs. The controls and switches permit checking of the functions as indicated on the box. The simulator outputs go to the signal J-box in place of the normal input data. Three adjustable power supplies are necessary as inputs to the box. They are as follows: +30V DC, +10V DC, -10V DC supplies. A 115 AC line is necessary for the open and closed deck tests. The indicated input levels to the box from the supplies are the maximum levels to each circuit under test. The potentiometers on the box permit adjustment of the output to the circuit under test to cover the full operating range.

A standard 115V 60 Hz test synchro is used to test the displays driven by the ship's synchro output. The test synchro is a three line (S1, S2, and S3) unit having 115V 60 Hz two line reference input with a 0° to 360° dial at its end to adjust the output related to degree rotation. The S1, S2, S3 signals, and reference signals are applied to the synchro signal J-box in place of the normal ship's signals for the functions to be tested.

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APPENDIX

12.1 Scale Removal

All the scales are removable from the front of the console. The following three steps must be followed before any of the scales can be removed. Handle polarized plastic faceplate with care to prevent scratching.

1. Console should be in an inside, dry and protected area with all electrical power turned off.
2. Remove the four screws in the corners of the LS-458/SIC intercom and remove the intercom by pulling straight out.
3. Remove all the screws in the bezel around the outer edge of the plastic faceplate, then carefully remove the bezel and the faceplate.
4. Each scale is then removed as follows:

Ramp Motion

(a) Follow steps 1, 2 and 3 and then loosen the two captive screws located on the two ends of the scale.

(b) Remove scale part way and then disconnect the connector on rear of the scale by reaching in through the intercom opening.

Airspeed

(a) Follow steps 1, 2, and 3 under Scale Removal and then loosen the captive screws on the two ends of the scale.

(b) Remove scale part way and then disconnect the connector on rear of the scale by reaching in through the intercom opening.

ACLS

(a) Follow steps 1, 2 and 3 under Scale Removal and then loosen the two captive screws on the top and bottom of the scale.

(b) Remove scale part way and then disconnect connectors on rear of scale by reaching in through the intercom opening.

Rate of Descent

(a) Follow steps 1, 2 and 3 and then either follow the steps for removing the ACLS scale or for opening the back of the console. Either one of these steps will be necessary to allow access to disconnect the connector from the rear of the Rate of Descent (or Sink Rate)scale.

(b) Disconnect connector.

(c) Remove scale by loosening the two captive screws at the top and bottom of the scale.

Range Scale

(a) Follow steps 1, 2 and 3 and then loosen the two captive screws from both ends of the scale.

(b) Remove scale by pulling straight out.

12.2 HUD Scale Lamp Replacement

The HUD Scale lamp should be visually inspected frequently for signs of blackening. In case of blackening or burn out, the lamp should be replaced with an identical lamp. (4596 Aircraft Landing Lamp. PAR-36, 28 volt, 250 watt)

1. Turn off the power to the console and, if time is available, allow lamp housing to cool a few minutes to prevent burning fingers.

2. Lamp housing on rear of console is unlocked and hinged down by pulling outward on the two knurled knobs on the ends of the housing.

3. Remove lamp by rotating lamp retaining clips clockwise.

4. Loosen screws on back of lamp and remove power leads.

5. Replace new lamp by following the removal steps in the reverse order.

12.3 Removal of Rear Access Panel of Console

1. Turn off power to console.

2. Pull outward on the two knurled knobs at the ends of the lamp housing and lower housing to an open position.

3. Loosen all captive screws around outer edge of panel, including the three screws located inside the lamp housing. Close the lamp housing. Lower panel on hinges.

4. Panel may be removed from console completely by unplugging the two electrical plugs and moving panel to the right to separate the hinge pins.

12.4 Removal and Installation of HUD CRT Assembly

1. Turn off all power to the unit.

2. Place the spherical concave mirror in the raised position and secure it as for normal operation.

3. Raise the combiner until the guide pins in the track are at the slots 1-1/2 inches from the fully raised position.

4. At all times carefully support the glass combiner.

5. Compress the two round knobs at the bottom edge of the combiner toward the center to release pressure on the track and lift the bottom edge out of the slots.

6. Remove the right edge of the combiner from its pivot support by pushing on the arm at the glass edge and moving the glass to the left. Store the combiner in a safe place until ready for installation.

7. Remove the eight (8) Allen head 10-32 stainless steel screws on the top around the CRT protection glass or plastic cover.

8. Release the hinged back by releasing the 18 captive screws including the ones covered by the lamp housing see section 12.3. Remove the back completely by disconnecting the motor and lamp plugs and sliding the back to the right off of its pin hinges. The back may be left on by carefully letting it hinge down against the rear carrying bar.

9. Remove the high voltage lead to the CRT at the plug.

10. Disconnect the two plugs directly in back and at the bottom of the CRT shield.

11. Disconnect the grid control (G1) lead (green wire) at the small connector.

12. Remove the assembly ground lead (black) from the left side and re-tighten the screw to clear the top cut out.

13. Clear all disconnected plugs from other wiring.

14. Grasp the assembly by the CRT shield and lift up until the unit can be handled from the outside.

15. Finally remove the assembly from above being very careful not to touch, scratch or damage the spherical concave mirror above.

16. Insert a replacement assembly HUD or the same unit after service by reversing the above operations proceeding from 15 to 1.

J100	FUNCTION	CONNECT TO	WIRE COLOR
1	DECK MOTION analog input	100-wire cable, wire #9	Green
2	SINK RATE analog input	Scale Display chassis J400/A	White
3	AIRSPEED analog input	P36-25	Orange
4	Not used	- - - - - - -	
5	-14.8V power input	HUD Display chassis J1/7	Yellow
6	+14.80V power input	HUD Display chassis J1/8	Red
7	Not used	- - - - - - -	
8	Enabling gate input for AIRCRAFT SYMBOL position	HUD Display chassis J1/B; switch S22	Yellow (128-75)
9	Enabling gate input for tail of AIRCRAFT SYMBOL	HUD Display chassis J1/2	
10	Enabling gate input for wings of AIRCRAFT SYMBOL	HUD Display chassis J1/D	
11	Enabling input for 10 ft/div range of GLIDE SLOPE LINE UP	Glide-Slope Range Change switch (S22)	Red (128-99)
12	Input reset pulses for pointer linear sweep generator	HUD Display chassis J1/V	
13	Not used	- - - - - - -	
14	Common	HUD Display chassis J1/12	Black
15	Not used	- - - - - - -	
16	Enabling gate input for RANGE circle	HUD Display chassis J1/17	
17	Not used	- - - - - - -	
18	Output for RANGE-circle blanking generator	HUD Display chassis J1/15	
A	GLIDE SLOPE LINE UP analog input, azimuth	100-wire cable, wire #30	Red
B	GLIDE SLOPE LINE UP analog input, elevation	100-wire cable, wire #31	Brown
C	RANGE analog input	Scale Display chassis J100/A	Purple
D	Common	- - - - - - -	
E	Enabling gate input for DECK MOTION pointer	HUD Display chassis J1/F	
F	Enabling gate input for AIRSPEED pointer	HUD Display chassis J1/E	
H	Not used	- - - - - - -	
J	790 Hz square wave input for pointer width	HUD Display chassis J1/T	
K	395 Hz square wave input for pointer width	HUD Display chassis J1/18	
L	Enabling gate input for circle portion of AIRCRAFT SYMBOL	HUD Display chassis J1/4	
M	Not used	- - - - - - -	
N	X-axis deflection output	Deflection Amplifier terminal #1	Yellow
P	Y-axis deflection output	Deflection Amplifier terminal #7	White
R	Not used	- - - - - - -	
S	Input rest pulses for the RANGE linear ramp generator	HUD Display chassis J1/P	
T	Not used	- - - - - - -	
U	Input for 790 Hz sinewave, 0°	HUD Display chassis J1/1	
V	Input for 790 Hz sinewave, +90° phase lead	HUD Display chassis J1/A	

WIRING TABLE FOR SOCKET J100 on HUD Display Chassis

12.5 HUD Circuit Card Wiring Table

J1	FUNCTION	CONNECT TO	WIRE COLOR
1	790 Hz sinewave output (10V p-p, 0°)	HUD Display chassis J100/U	
2	Enabling gate output for tail of AIRCRAFT SYMBOL	HUD Display chassis J100/9	
3	Not used	- - - - - -	
4	Enabling gate output for circle portion of AIRCRAFT SYMBOL	HUD Display chassis J100/L	
5	790 Hz rectangular wave output, a trouble-shooting aid	- - - - - -	
6	Not used	- - - - - -	
7	-14.8V output	HUD Display chassis J100/5	Yellow
8	+14.80V output	HUD Display chassis J100/6	Red
9	Not used	- - - - - -	
10	Common	Common bus	Black
11	Common	- - - - - -	
12	Common	Glide-Slope Range Change switch (S22)	Brown (128-100)
13	Common	HUD Display chassis J100/14	Black
14	Not used	- - - - - -	
15	From RANGE circle blanking generator	HUD Display chassis J100/18	
16	Not used	- - - - - -	
17	Enabling gate output for RANGE circle	HUD Display chassis J100/16	
18	395 Hz Square wave output for pointer width	HUD Display chassis J100/K	
A	790 Hz Sinewave output (16V p-p, +90° phase lead)	HUD Display chassis J100/V	
B	Enabling gate output for AIRCRAFT SYMBOL position	HUD Display chassis J100/8	
C	When grounded, tail and wings appear on AIRCRAFT SYMBOL	Glide-Slope Range Change switch (S22)	Gray (128-73)
D	Enabling gate output for wings of AIRCRAFT SYMBOL	HUD Display chassis J100/10	
E	Enabling gate output for AIRSPEED pointer	HUD Display chassis J100/F	
F	Enabling gate output for DECK MOTION pointer	HUD Display chassis J100/E	
H	Output is low when RANGE is less than 1 nautical mile	Glide-Slope Range Change switch (S22)	Violet(128-94)
J	Not used	- - - - - -	
K	-20V input	-20V bus	Yellow
L	+20V input	+20V bus	Orange
M	Not used	- - - - - -	
N	+5V output, 10kΩ source resistance	Glide-Slope Range Change switch (S22)	Orange (128-74)
P	790 Hz reset pulses for RANGE linear ramp generator	HUD Display chassis J100/S	
R	Blanking output	CRT Control chassis terminal A	Blue
S	When grounded, entire CRT display is blanked	S21 (Lamp & CRT beam On-Off switch)	Violet (128-76)
T	790 Hz Square wave output for pointer width	HUD Display chassis J100/J	
U	Enabling gate for automatic range change of GLIDE-SLOPE	Glide-Slope Range Change switch (S22)	Green (128-96)
V	1580 Hz reset pulses for pointer ramp and CRT Protection	HUD Display J100/12; CRT Protection #7	Red

WIRING TABLE FOR SOCKET J1 on HUD Display Chassis

12. 5 HUD Circuit Card Wiring Table

12.6 HUD Calibration Table

Ramp Motion: ± 10V gives full-scale deflection

Airspeed:		
+ 3.13V	=	80 knots
3.91V	=	100 "
5.09V	=	130 "
6.26V	=	160 "
7.04V	=	180 "

Range:		
+ 2.58V	=	1/4 mile
5.16	=	1/2 "
7.74	=	3/4 "
10.32	=	1.0 "

Aircraft Symbol:

Divisions	10 ft/div	30 ft/div	X or Y
0	0V	0V	X
3	2.93V	--	"
5	4.88V	--	"
8	7.80V	23.4V	"
0	0V	0V	Y
3	2.36V	7.05V	"
5	3.92V	11.77V	"
8	6.28V	18.82V	"

12.7 Physical Characteristics of LSO Console, Panning Head, and Auxiliary Electronic Cabinet

Console (Approx. Size and Weight)

1. Weight: 54.43 kg (120 lbs)
2. Width with spherical concave mirror in stored (down) position: 64.44 cm (25.375 in)
3. Height including rubber feet: 44.68 cm (17.625 in)
4. Depth including HUD lamp box and front and back carrying handles: 64 cm (25.25 in)

Panning Head (Approx. Size and Weight)

1. Width: 30.5 cm (1 ft)
2. Height: 17.8 cm (7 in)
3. Depth: 19 cm (7.5 in)
4. Weight: 7.26 kg (16 lbs)

Auxiliary Electronic Cabinet (Approx. Size and Weight)

1. Height: 124.5 cm (49 in)
2. Width: 66 cm (26 in)
3. Depth: 64 cm (25.25 in), with door handles 68.6 cm (27 in)
4. Weight: 104.33 kg (230 lbs)

12.8 Electronic Diagrams

	Block Diagram	Drawing
Plat Monitor Changes	1EB	1E
CRT, G1, G2, G4 and 15kV Power Circuits	2EB	2E
CRT Power & Defl. Amp. Front View Layout		3E

<u>Mechanical Drawings</u>

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16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

This manual describes the prototype Landing Signal Officer's (LSO) Display System that is installed aboard the USS Ranger CVA61 Aircraft Carrier. The prototype LSO Console was designed and engineered to fulfill requirements proposed in a study for an improved LSO work station. The first four sections (1.0 thru 4.5) of this manual provide the information needed to operate the equipment, while the remaining sections give a technical description of the equipment and will be useful when service or modifications are required. The technical sections are written to be used in conjunction with the electronic and mechanical drawings furnished with the equipment.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)* Aircraft carrier landings monitoring; Aircraft airspeed, range, and rate of descent monitor; Carrier ramp motion repeater; Head-up display (HUD); Landing signal officer's console; MOVLAS repeater.

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